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Economic Impact Analysis of Effluent Limitations and Standards for the Copper Forming Industry

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The U.S. Environmental Protection Agency promulgated effluent limitations and standards for the copper forming industry in August 1983. This report provides analysis of the economic impacts of pollution control costs for the industry. The economic impacts are measured in terms of price changes, production changes, plant closures, employment effects and balance-of-trade effects.

To assess these impacts, plant-specific compliance costs and financial data for a representative sample of copper formers were used. The methodology included analyses of the industry structure and performance, prices, demand and supply of copper products, capital availability, and plant closures. The results were extrapolated to include all copper forming plants that discharge wastewater. No plant closures or job losses are projected as a result of the compliance costs for this regulation. Changes in price would be very small because of the demand and supply elasticties for copper forming products. No measurable balance of trade effect is expected.

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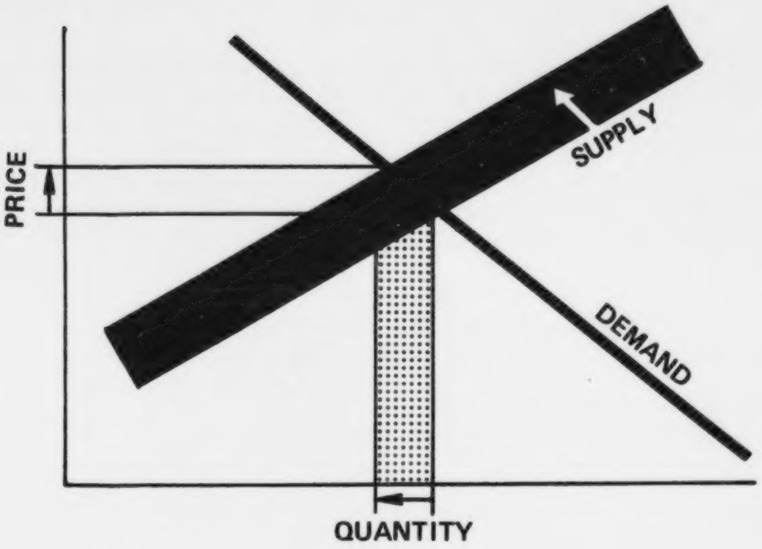

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This document is an economic impact assessment of the recently-issued effluent guidelines. The report is being distributed to EPA Regional Offices and state pollution control agencies and directed to the staff responsible for writing industrial discharge permits. The report includes detailed information on the costs and economic impacts of various treatment technologies. It is should be helpful to the permit writer in evaluating the economic impacts on an industrial facility that must comply with BAT limitations or water quality standards.

The report is also being distributed to EPA Regional Libraries, and copies are available from National Technical Information Service (NTIS), 5282 Port Royal Road, Springfield, Virginia 22161, (703)-487-4650.

If you have any questions about this report, or if you would like additional information on the economic impact of the regulation, please contact the Economic Analysis Staff in the Office of Water Regulations and Standards at EPA Headquarters:

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ECONOMIC IMPACT ANALYSIS OF EFFLUENT LIMITATIONS AND STANDARDS FOR THE COPPER FORMING INDUSTRY

Submitted to:

Environmental Protection Agency
Office of Analysis and Evaluation
Office of Water Regulations and Standards
401 M Street, S.W.
Washington, D.C. 20460

July 1983

PREFACE

This document is a contractor's study prepared for the Office of Water Regulations and Standards of the Environmental Protection Agency (EPA). The purpose of the study is to analyze the economic impact which could result from the application of effluent standards and limitations issued under Sections 301, 304, 306, and 307 of the Clean Water Act to the Copper Forming industry.

The study supplements the technical study (EPA Development Document) supporting the issuance of these regulations. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports certain standards and limitations based upon an analysis of the feasibility of these standards in accordance with the requirements of the Clean Water Act. Presented in the Development Document are the investment and operating costs associated with various control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the application of various control methods and technologies. This study investigates the impact on product price increases, employment and the continued viability of affected plants, and foreign trade.

This study has been prepared with the supervision and review of the Office of Water Regulations and Standards of EPA. This report was submitted in fulfillment of EPA Contract No. 68-01-6348 by JRB Associates. This analysis was completed in July 1983.

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EXECUTIVE SUMMARY

This report presents an analysis of the economic impacts of EPA effluent regulations on the copper forming industry. This analysis was prepared under the supervision of the Office of Analysis and Evaluation, U.S. Environmental Protection Agency.

PURPOSE

The purpose of this study is to analyze the economic impacts that are likely to result from the promulgation of effluent regulations on the copper forming industry. These regulations are being promulgated under the authority of the Clean Water Act. The analysis considers:

- Effluent limitations based on the Best Available Technology Economically Achievable (BAT) to be met by industrial dischargers by July 1984;
- New Source Performance Standards (NSPS) to be met by new source industrial dischargers;
- Pretreatment Standards for Existing Sources (PSES) to be met by existing dischargers to publicly owned treatment works (POTWs); and
- Pretreatment Standards for New Sources (PSNS) to be met by new dischargers to publicly owned treatment works (POTWs).

The economic impacts of the effluent regulations include changes in prices and the quantities produced, changes in profitability, and changes in capital requirements and availability. In addition, the number of plant closures, employee layoffs, and community and balance-of-trade impacts resulting from the regulation are assessed.

METHODOLOGY

In general, effluent regulations impose added costs on plants in the industry. These costs include capital expenditures on pollution control equipment (fixed costs) and operating and maintenance expenses (variable costs), both of which cause the average production costs of a plant to increase. Under such conditions plant owners have the following options:

- Raise the price of their products and pass through some or all of the increased costs to purchasers;
- Absorb the increase in costs;
- Shut down the operation and go out of business.

The approach to this study begins with a determination of which option(s) producers in the copper forming industry are most likely to follow and what the resulting price and output levels are likely to be. Then, capital budgeting techniques are used to evaluate the financial status of copper forming plants before and after compliance with the effluent regulations. Other impacts such as employment, community, and foreign-trade effects are evaluated based on effluent regulation impacts on the industry.

The following several pages describe the information sources used in the analysis and the analytical techniques used in specific steps in the analysis.

Information Sources

This study is based on data from several sources. They include government reports, text books, trade association data, the trade press, discussions with individuals associated with the industry, and, of particular importance, a plant- and firm-level survey conducted by EPA under authority of Section 308 of the Clean Water Act (the 308 Economic Survey).

The 308 Economic Survey was designed to provide accurate and current information on the economic and financial characteristics of the industry's plants and firms. Data collected included information on market structure, profitability, depreciation, salvage value, investment in new capital, and value added. The survey questionnaire was mailed to every known plant in the copper forming industry. A total of 105 plants (i.e., approximately 60 percent of all copper forming plants) responded to the 308 Economic Survey.

All the survey questionnaires were returned directly to EPA by the respondents, and procedures were employed to protect the confidentiality of the data. These procedures included EPA removing the identification section from each questionnaire and assigning a code number to each before forwarding to the contractor for processing. The data from the survey, together with estimates of the costs of alternate water pollution control options, served as the most critical information inputs to the economic impact analysis.

Description of the Industry

The first step in the analysis describes the basic industry characteristics that relate to the impacts of the regulation. This analysis focuses on the end-use markets for copper products, substitution, foreign competition, number and types of firms and plants, and price trends. These factors determine the future growth and competitiveness of the industry and are important in assessing the copper forming producer's ability to afford additional capital outlays for pollution control equipment.

Industry Structure and Performance

The next step in the analysis focuses on the industry structure and performance. Industrial organization theory states that the performance of a firm in an industry is determined by the conduct of the firms in the market. The firm's market conduct is, in turn, dependent on the structure of the industry and market conditions prevailing in the economy at the time. Certain market structures (e.g., monopoly) imply that the participants may have higher profit margins and may be able to absorb or pass through added costs with less financial difficulty than other types of firms (e.g., firms in competitive markets). This analysis, therefore, provides information on the copper forming industry structure and performance, in order to provide insights into the industry's ability to absorb or pass through the added costs of compliance with EPA's effluent regulations.

Base-Case Analysis

This step of the analysis involves the development of economic projections under the assumption that no water pollution control requirements mandated by the Clean Water Act are imposed on the copper forming industry over the 1981-1990 period. The basic approach followed in developing the projections begins with the development of explicit demand and supply functions that explain the behavior of the copper forming domestic market over the 1960-1979 period. The forecasts of future levels of demand and supply for each of the major product groups are calculated from the established historical relationships and on projections of the explanatory variables of the demand and supply functions. Forecasts of the number of new plants are also given.

Compliance Cost Estimates

The water treatment control systems, costs, and effluent limitations and pretreatment standards recommended for the copper forming industry were derived in a separate analysis. A comprehensive description of the methodology and the recommended technologies and costs are provided in the Development Document for Effluent Limitations Guidelines and Standards for the Copper Forming Point Source Category (Development Document). Several treatment and control options based on BPT, BAT, NSPS, PSES, and PSNS for facilities within the copper forming category are considered. They consist of:

- Option 1: Option 1 is end-of-pipe treatment consisting of lime precipitation and settling, and preliminary treatment, where necessary, consisting of chemical emulsion breaking, oil skimming, and chromium reduction. For forged parts, this option also consists of spray rinsing and recirculation for pickling rinse and flow normalization for alkaline cleaning rinse. This combination of technology reduces toxic metals, conventional pollutants, and also toxic organics through oil skimming.

- Option 2: Option 2 is equal to Option 1 plus flow reduction for three waste streams: annealing water, solution heat treatment, and pickling rinse. Flow reduction of the annealing water and solution heat treatment streams is based on recycle, and flow reduction of the pickling rinse stream is based on spray rinsing and recirculation. The Option 1 flows for these streams are reduced and this reduction will decrease toxic metals and conventional pollutants.

- Option 3: Option 3 is equal to Option 2 plus filtration for further reduction of toxic metals and TSS.

- Option 4: Option 4 consists of lime precipitation, settling, and filtration, and, where necessary, preliminary treatment consisting of chemical emulsion breaking, oil skimming, and chromium reduction, with countercurrent rinsing and other methods of flow reduction.

- Option 5: Option 5 is equal to Option 1 plus filtration for further reduction of toxic metals and TSS.

A detailed description of these technologies and the development of their costs is in the Development Document. The costs of the pollution control options were developed by EPA's engineering staff and provided to the economic analysis study team for use in the economic impact analysis.

Price Impact Analysis

The extent to which the proposed pollution control costs can be passed through to the customers is analyzed separately. This analysis is important because it establishes (1) who is likely to bear the costs of the regulations (i.e., the consumers, producers, or both) and (2) the degree of impacts on the markets for copper forming products (i.e., impacts on demand, supply, and imports). The increase in the prices of copper forming products that is likely to occur if pollution controls are required is estimated via a microeconomic demand/supply analysis of all the product markets in the copper forming industry.

In general, compliance with effluent limitations increases the production costs of firms. This cost increase can be translated as an upward shift in the supply curve of the firms in the industry. The interaction of the new supply and the demand curves determines the new price. In this analysis, the movements of the supply and demand curves are simulated by the information provided in the demand and supply price elasticities of the copper forming products, under the assumption that competitive market conditions exist. The impact of an increase in costs on price in a single-product market is shown to depend on the elasticities of supply and demand in that market.

Demand and supply curves are constructed to provide these elasticity estimates. The percent price increases are used in conjunction with the additional per-unit pollution control costs to calculate the likely price increases for each product market.

Capital Availability Analysis

The capital availability analysis examines the ability of participants in the industry to finance investments in new capacity, both with and without pollution control. The approach focuses on the ability of participants to finance capital investments from their current cash flow, without relying on outside sources of capital. An implicit assumption in this approach is that if a plant can invest in pollution control and still remain profitable, given the current cost of capital, the capital market would also be willing to provide the money for the pollution control investment. A capital budgeting approach that considers the profitability of the plant, assuming that it decides to install the pollution control equipment, is used. If the net present value of the plant's cash flow is positive after the investment is made, the plant could afford to purchase the equipment. If the net present value of the cash flow is negative, the plant could not afford to install the pollution control equipment.

Plant Closure Analysis

In general, the proposed pollution control requirement will force a rational plant owner to decide (a) whether to make an additional investment and incur additional fixed and operating costs or (b) to sell the plant. The alternatives available to the owner are to:

- Sell the plant--either as an operating entity or as scrap, or
- Make the investment and realize the value of the cash flows expected from remaining open.

Because a plant will remain open for several years if the owner invests to meet the pollution control limitations, the analysis takes into account the expected cash flow over the life of the plant plus the salvage value of the plant at the end of the last period. The future cash flow of the plant is discounted back to the present year, using a discount rate equal to the firm's cost of capital. The plant will be kept open if the expected discounted cash flow less investment costs (net cash flow) exceeds the expected salvage value of the plant. If the discounted net cash flow is less than the salvage value, a rational owner would sell the plant because he would receive a larger return from liquidating it than from continuing its operation.

Other Impacts

The compliance with EPA effluent regulations can have both direct and indirect impacts on employment, balance of trade, and earnings in the community. Direct employment and earnings impacts would result from plant closures, and indirect impacts would result from price increases and the subsequent production, employment, and earnings decreases. Given the changes that may result from the regulation these additional impacts are estimated.

Small Entity Analysis

The Regulatory Flexibility Act (RFA) requires Federal regulatory agencies to consider small entities throughout the regulatory process. A small entity analysis of the copper forming industry is performed to determine if small entities will be significantly impacted by the regulation and to ascertain if a Regulatory Flexibility Analysis is needed. The definition of small entity is not precise or universal and several criteria (e.g., plant production, employment, wastewater flows) are examined for identifying small plants in the copper forming industry. In this section the small plants in our data base are examined to determine whether these plants would be more significantly affected by the water regulations than larger plants.

SUMMARY OF ECONOMIC IMPACTS

Market Description

The copper forming industry consists of approximately 176 plants that form copper and copper alloys into intermediate and finished products.[1] These plants are generally divided into two categories: brass mills and wire mills. Together they consumed approximately 4.46 billion pounds of copper in 1982. This industry employs approximately 43,000 employees. The output of the industry dropped from a high of 6.1 billion pounds of copper in 1979 to 4.5 billion pounds in 1982. The industry's poor performance in this year was a result of the prolonged period of high interest rates and the recession which depressed sales in the end-use markets. Prices during this period also fell significantly. U.S. producer prices in 1982 averaged $0.74 per pound, down from a record high of $1.45 per pound in February 1980. In recent times, there has been some improvement in the price of copper and this trend is expected to continue over the 1983-1984 period. These improved conditions are mainly due to the improvement in the economy and to reductions in inventories of copper products.

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[1] In this report the term "copper" is generally used to refer to both copper and its alloys.

Industry Structure and Performance

Although a large segment of the market is vertically integrated, the structure of the copper forming segment is relatively competitive. This type of market structure suggests that individual firms in the copper forming industry are unlikely to be in a position to control or influence the market or prices in a perceptible manner. Market concentration is low and entrance into the industry is relatively easy. An analysis of the firm's key financial ratios suggests that the industry is earning profits slightly below those of comparable industries. The data also indicate that the industry may be in a position to finance moderate levels of additional debt in the future.

Baseline Projections of Industry Conditions

The results of the baseline projections show that the growth in demand and supply for the various types of copper forming products is likely to be strong among the product groups. The highest growth in the demand segment of the market is for the sheet, plate, and strip products which is expected to increase by 86 percent over the 1982-1990 period. The smallest increase in demand is projected for plumbing tube and pipe products. This market segment is expected to increase by 37 percent over the 1982-1990 period. The demand increases for the other products range between 74 and 78 percent.

Overall, the growth in the domestic supply of copper forming products is estimated to be slower than the estimated growth in demand over the period examined. The supply of the rod, bar, and mechanical and the sheet, strip, and plate segments are projected to increase by 82 and 81 percent above their 1982 level of output by 1990, respectively. The growth in the output of the other copper forming products ranges between 57 and 60 percent.

The severity of the 1981-1982 recession has depressed sales of copper forming products which has forced the industry to cut back its production in 1982. However, recent economic indicators suggest that the industry will recover to previously attained output and demand levels during the 1984-1990 period.

There has been very little growth in new plant capacity over the last decade. Additionally, there is excess capacity in the industry at the current time. This is a result of the 1981-1982 recession which forced plants to cut back their production levels. A review of the annual reports of copper forming plants indicates that four new plants and two major plant expansions are planned for the future. The existing plants plus these new plants would provide the capacity necessary to attain the increases in the output that are predicted in 1990.

Results of the Plant-Specific Analysis

Table S-1 summarizes the economic impacts that would result from the promulgation of the effluent limitations. Of the 176 plants in the copper forming industry, 94 plants do not discharge wastewater. The remaining 82 plants consist of 37 direct dischargers and 45 indirect dischargers. These represent the plants in the copper forming industry that would incur costs to install, operate, and maintain the pollution control treatment systems.

For the selected options the BAT and PSES regulatory costs these plants would incur are estimated at $15.7 million for investment and $10.5 million for operating and maintenance. The total annual compliance costs for the industry would be $14.0 million. These costs are estimated to have an

TABLE S-1. SUMMARY OF ESTIMATED ECONOMIC IMPACTS OF EFFLUENT LIMITATIONS--COPPER FORMING INDUSTRY

IMPACT VARIABLE	POLLUTION CONTROL TECHNOLOGY					
	DIRECT			INDIRECT		
	OPTION 1	OPTION 2*	OPTION 3	OPTION 1	OPTION 2*	OPTION 3
Number of Plants Incurring Costs	37***	37	37	45	45	45
Total Industry Pollution Control Investment Cost ($ Millions)**	5.8	6.5	7.9	8.8	9.2	10.4
Total Industry Pollution Control Operating and Maintenance Costs ($ Millions)**	4.8	4.9	5.6	5.7	5.6	6.1
Total Annual Pollution Control Costs ($ Millions)**	6.1	6.3	7.4	7.6	7.7	8.3
Product Price Changes (Percent)	0.16	0.18	0.20	0.60	0.70	0.80
Output Changes (Percent)	None	None	None	None	None	None
Predicted Capital Impacts	None	None	None	None	None	None
Predicted Plant Closures	None	None	None	None	None	None
Employment Impacts	None	None	None	None	None	None
Community Impacts	None	None	None	None	None	None
Foreign-Trade Impacts	None	None	None	None	None	None
Small Entity Impacts	None	None	None	None	None	None

*Denotes the selected option.

**1982 dollars.

***11 of the 37 are estimated to meet Option 1 limitations but these 11 share in the total costs because operating and maintenance costs for treatment in place are included here.

insignificant impact (less than one percent) on the price of copper forming products. Because of the insignificant price changes, no production or balance-of-payment impacts are expected from this regulation.

The results also indicate that the impacted plants would experience some profit reductions, but these would not be significant enough to cause plant closures or employee layoffs. Additionally, the results of the capital availability analysis indicate that the plants would be able to finance installation of the required pollution abatement technologies.

The initial capital investment and operating and maintenance costs associated with NSPS and PSNS are estimated at $1.23 million and $0.8 million per plant, respectively.[2] Relative to revenues and plant assets, these costs are similar to the costs for BAT and PSES and, therefore, are not likely to present a barrier to new plants entering the industry.

The small entities analysis provides no evidence that the profitability of small plants is different from that of larger plants. The regulation is not expected to cause any of the small plants to close or layoff employees. For these reasons, the Agency has determined this regulation is economically achievable.

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[2] The NSPS and PSNS costs are for a "normal" plant as defined in Section VIII of the Development Document. It is a theoretical plant which has each of the manufacturing operations covered by this regulation and production that is average for the industry as a whole.

1. INTRODUCTION

1.1 BACKGROUND

The Environmental Protection Agency is charged with the responsibility to restore and maintain the chemical, physical, and biological integrity of the nation's waterways. This authority is granted under the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972 as amended by the Clean Water Act of 1977). Section 301(b)(1)(A) of the Act requires that all industries discharging into navigable waterways achieve the "best practicable control technology" (BPT). These same dischargers are required to meet effluent limitations achievable by the application of "best available technology economically achievable" (BAT) and best conventional pollutant control technology pursuant to Sections 301(b)(2)(A), (b)(2)(C), and (b)(2)(E). Additionally, new industrial dischargers are required to comply with the New Sources Performance Standards (NSPS) under Section 306 of the Act, and new and existing industrial dischargers to publicly owned treatment works (POTWs) are subject to Pretreatment Standards under Sections 307(b) and 307(c) of the Act. The Agency is now promulgating these effluent limitations and standards for the copper forming industry. In developing these standards the Agency has extensively examined the technical and economic characteristics of the copper forming industry and the technical and economic characteristics of several alternative pollution control technologies. This report describes the economic impact analysis. The technical analyses are presented by EPA in a separate document.

1.2 PURPOSE

The purpose of this study is to analyze the economic impacts that are likely to result from the promulgation of EPA's effluent regulations on the copper forming industry. This analysis considers:

- Effluent limitations based on the Best Available Technology Economically Achievable (BAT) to be met by industrial dischargers by July 1984;
- New Source Performance Standards (NSPS) to be met by new source industrial dischargers;
- Pretreatment Standards for Existing Sources (PSES) to be met by existing dischargers to publicly owned treatment works (POTWs); and
- Pretreatment Standards for New Sources (PSNS) to be met by new dischargers to publicly owned treatment works (POTWs).

This study analyzes the impacts of the costs for alternative pollution control regulatory options on plant profitability, capacity expansion and replacement, and the potential for plant closures in the U.S. copper forming industry. In addition, the impacts of the regulation on employment, communities, foreign trade, and small businesses are considered.

1.3 SCOPE

1.3.1 Industry Coverage

For purposes of this study, the copper forming industry includes 176 plants that form copper and copper alloys into intermediate and finished copper and copper alloy products. The industry is classified under the following Standard Industrial Classification (SIC) groups:[1]

- SIC 3351 - Rolling, drawing, and extruding of copper, brass, bronze, and other copper-base alloys into shapes such as plate, sheet, bar, and tubing.
- SIC 3357 - Drawing copper and copper-base alloy wire, and other copper wire products within the nonferrous wire drawing and insulating industry group.

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[1] Included in this analysis of the copper forming industry is most of SIC 3351 and some, but not all, of SIC 3357.

The plants covered under this regulation produce the following:

- Brass Mill Products
  - Sheet, Strip, and Plate
  - Rod, Bar, and Mechanical Wire
  - Plumbing Tube and Pipe
- Wire Mill Products (Wire and Cable).

1.3.2 Regulatory Options Considered

EPA considered five treatment and control options for the BPT, BAT, NSPS, PSES, and PSNS regulations. These are:

- Option 1: Option 1 is end-of-pipe treatment consisting of lime precipitation and settling, and preliminary treatment, where necessary, consisting of chemical emulsion breaking, oil skimming, and chromium reduction. For forged parts, this option also consists of spray rinsing and recirculation for pickling rinse and flow normalization for alkaline cleaning rinse. This combination of technology reduces toxic metals, conventional pollutants, and also toxic organics through oil skimming.

- Option 2: Option 2 is equal to Option 1 plus flow reduction for three waste streams: annealing water, solution heat treatment, and pickling rinse. Flow reduction of the annealing water and solution heat treatment streams is based on recycle, and flow reduction of the pickling rinse stream is based on spray rinsing and recirculation. The Option 1 flows for these streams are reduced and this reduction will decrease toxic metals and conventional pollutants.

- Option 3: Option 3 is equal to Option 2 plus filtration for further reduction of toxic metals and TSS.

- Option 4: Option 4 consists of lime precipitation, settling, and filtration, where necessary, preliminary treatment consisting of chemical emulsion breaking, oil skimming, and chromium reduction, with countercurrent rinsing and other methods of flow reduction.

- Option 5: Option 5 is equal to Option 1 plus filtration for further reduction of toxic metals and TSS.

A description of these technologies and associated compliance costs is contained in chapter 5.[2]

1.4 ORGANIZATION OF THE STUDY

The remainder of the study is organized into six chapters. The complete methodology of the study is outlined in chapter 2. Chapter 3 provides a description of the copper forming industry and the key factors that influence the market. Chapter 4 evaluates the structure of the industry as well as the economic and financial performance of copper forming firms over their recent history. Chapter 5 provides the baseline conditions of the industry market assuming no further water pollution control requirements over the regulatory impact period. Chapter 6 details the costs of the alternative treatment technologies being considered. Chapter 7 presents the findings of the economic impact analysis, and chapter 8 summarizes the limitations.

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[2] The fifth option was rejected based on engineering judgment.

2. METHODOLOGY

This chapter summarizes the methodology, assumptions, and information sources used to analyze the economic impacts of the BAT effluent regulations on the copper forming industry. It describes the ways in which information on industry characteristics (from the 308 Economic Survey and from other sources) are used together with estimated compliance costs (from a separate study)[1] to identify plants that may not be in a position to afford the installation of pollution control equipment. This chapter also summarizes the approaches used to identify potential plant closures, employment, price, and other impacts on plants in the industry.

2.1 OVERVIEW

Effluent regulations generally impose added costs on plants in the industry. These costs include capital expenditures on pollution control equipment (fixed costs) and operating and maintenance expenses (variable costs). When the average production costs of a plant increase, plant owners will act according to one of the following options:

- Raise the price of their products and pass through some or all of the increased costs to purchasers;
- Absorb the increase in costs;
- Shut down the operation and go out of business.

The industry is analyzed in depth to determine which of these options copper formers are most likely to implement and, subsequently, an analysis of the impacts of the various pollution control technologies is carried out. Figure 2-1 shows the major elements and information flows of the analysis. The main elements of the analysis include the following eleven steps:

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[1] U.S. Environmental Protection Agency, Development Document for Effluent Limitations Guidelines and Standards for the Copper Forming Point Source Category, July 1983.

- Description of the Industry
- Industry Structure and Performance Analysis
- Demand and Supply Analysis
- Cost of Compliance
- Price and Production Impacts
- Capital Availability Analysis
- Plant Closure Analysis
- Employment Impacts
- Community Impacts
- Balance-of-Trade Impacts
- Small Entity Analysis.

The specific approach used in analyzing each of these elements is discussed in detail below.

2.2 SPECIFIC APPROACH

2.2.1 Description of the Industry

The first step in the analysis is to describe the basic characteristics of the copper forming industry, such as the nature of the products and markets, the historical trends of sales, end-use markets, prices, foreign trade, and the number, type, and location of firms and plants in the industry. This analysis establishes the growth rates of these key variables and the factors that influence the market for copper forming products. This information is useful in assessing the future competitiveness and the ability of the copper forming industry to afford additional capital outlays for pollution control equipment.

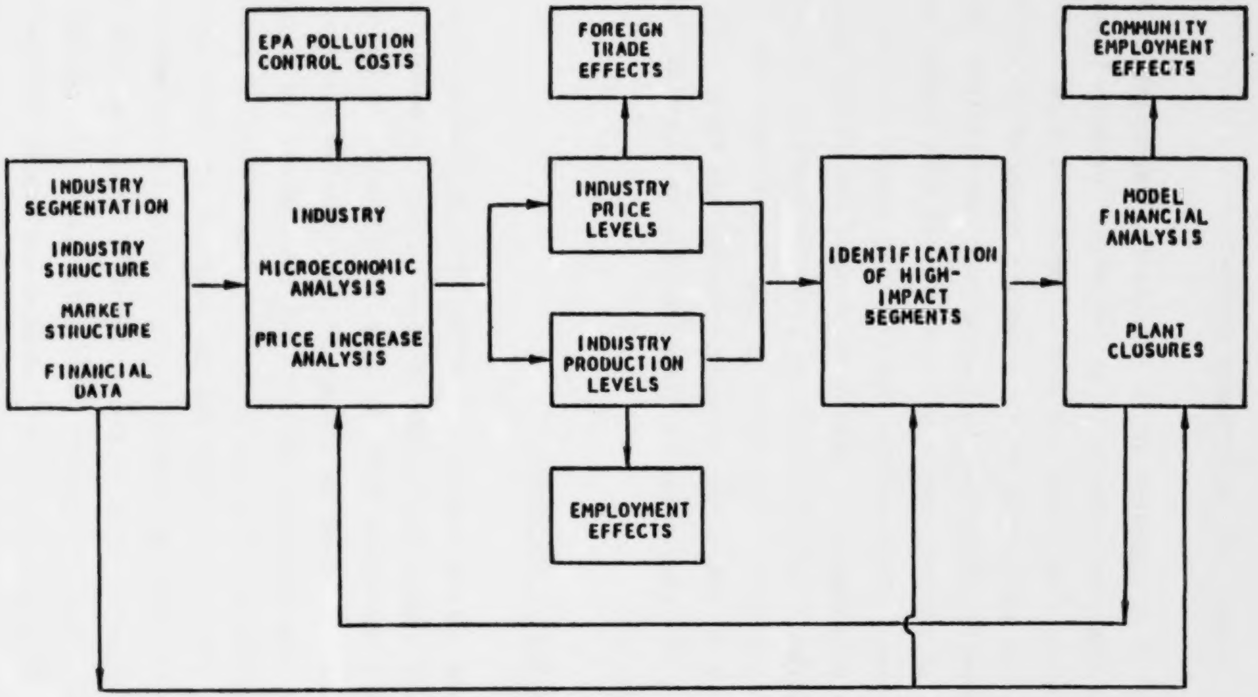
EPA POLLUTION CONTROL COSTS
FOREIGN TRADE EFFECTS
COMMUNITY EMPLOYMENT EFFECTS
INDUSTRY SEGMENTATION
INDUSTRY STRUCTURE
MARKET STRUCTURE
FINANCIAL DATA
INDUSTRY
MICROECONOMIC ANALYSIS
PRICE INCREASE ANALYSIS
INDUSTRY PRICE LEVELS
INDUSTRY PRODUCTION LEVELS
IDENTIFICATION OF HIGH-IMPACT SEGMENTS
MODEL FINANCIAL ANALYSIS
PLANT CLOSURES
EMPLOYMENT EFFECTS

FIGURE 2-1. ECONOMIC ANALYSIS STUDY OVERVIEW

2.2.2 Industry Structure and Performance Analysis

The structure of an industry is an important determinant of how a regulation will affect the participants in an industry. Certain industry structures (e.g., monopoly) imply that the participants have some control over their markets and can set prices or the quantity produced to maximize profits. Other forms of industry structures (e.g., perfect competition) imply that the participants have no control over their markets and must accept the prices of the products as given. This section analyzes the copper forming industry structure and its performance to establish whether the participants have control over their markets and are likely to pass the costs of pollution control through to their customers. This analysis also establishes the financial status of the firms in the copper forming industry and their ability to afford the added costs of the regulation if they cannot pass along all of the costs to their customers.

2.2.3 Demand and Supply Analysis

The demand and supply analysis quantitatively estimates changes in market prices and industry production likely to result from the regulation. The analysis produces a base-case forecast (i.e., a forecast in the absence of the BAT regulations) of sales and output of the domestic producers of copper forming products. The approach assumes that the markets for copper forming products are competitive. The demand for the copper forming products is determined by the prices of copper and the behavior of their end-use markets. The supply of copper forming products is determined by the prices of copper and the level of capacity utilization or level of inputs used by the industry in a given period. Explicit demand and supply curves are established for each of the copper forming product groups. Demand and supply forecasts by product group are established from the curves that are developed and on projections of the explanatory variables that are taken from various other sources. In addition, the supply forecasts are used to determine whether the industry would require significant capital expansions and/or new plants to attain the projected output levels.

2.2.4 Cost of Compliance

The costs of the treatment systems and their associated effluent limitation and standards were developed in a separate study[2]. The costs of compliance are estimated for individual plants in the copper forming industry. These costs include both capital and total annual costs.

A comprehensive description of the technical cost analysis methodology, recommended treatment systems, and costs is provided in EPA's Development Document.[3] EPA considered treatment and control options as the basis for BPT, BAT, NSPS, PSES, and PSNS for facilities within the copper forming industry.

The costs associated with the treatment options are used for predicting the impacts on prices, output, profitability, capital availability, and plant closures.

2.2.5 Price and Production Changes Analysis

The copper forming plants will attempt to adjust their price and output decisions so that their financial performance after compliance is as good as it was prior to regulation. This implies that a plant will attempt to recover the costs of compliance by raising the product prices if it can do so. The success of this attempt will be governed by the market resistance to price increases (i.e., price elasticity of demand) and intraindustry competition.

If all or a significant amount of the added costs can be passed through to the customers without affecting the volume of sales of the plants in the industry, then the impacts of the proposed effluent regulation on the plants would be small. On the other hand, if the pollution control costs cannot be passed along to the customers in the form of higher prices or if significant reductions in quantity demanded result from the price increases, then the plants in the industry would experience revenue and profit margin decreases due to the proposed effluent regulation. Consequently, it is important to estimate the likely extent of the price increase that may occur as a result of the regulations and to compare the price increases to expected cost increases at the various plants.

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[2] Ibid, p. 2-1.

[3] Ibid, p. 2-1.

The effects of an increase in production cost on price depends on both demand and supply conditions in the industry. In markets where the demand for the product is growing and the price is inelastic (i.e., the demand is insensitive to price changes), producers can usually pass cost increases through to their customers without losing sales. Under other market conditions (e.g., a stagnant product market and elastic product price), a smaller amount of the increased costs is likely to be passed through since the firms would lose significant amounts of revenues if they raised their prices significantly. Under the latter circumstances, firms have to absorb some or all of the increased costs, which may result in reduced output and profit levels and, possibly, plant closures.

To summarize the outcome of these forces, the impact of additional costs on a firm can be interpreted as a shift in the supply curve (i.e., an increase in the costs) of the firm. The increase in price is determined in the market by the interaction of the supply curve with a new position on the demand curve. As long as the cost increase is not too large, the assumption about the change in the supply curve due to the change in costs can be measured from information provided by the supply and demand price elasticities. That is, it can be shown that, in a competitive market, the change in price (ΔP) due to a change in cost (ΔMC) is equal to:

$$\frac{\Delta P}{\Delta MC} = \frac{\eta}{\eta - \varepsilon} \tag{2.1}$$

where η represents the supply price elasticity and ε the demand price elasticity for the specific copper forming product.[4] Using equation (2.1) the price increase due to a change in pollution control costs can be estimated as follows:

$$(2.2) \qquad \Delta P = \frac{\eta}{\eta - \varepsilon} \times \Delta MC$$

The change in cost (ΔMC) is defined as the additional pollution control costs per pound of output.

The elasticity estimates are provided by the demand and supply equations constructed in the supply/demand analysis described in section 2.2.3. Based on these estimates, the change in the price of the copper forming products due to the increase in costs of pollution control can be calculated.

The next step is to calculate the reductions in industry sales that are associated with the price increases. These reductions are calculated using the demand/supply model. Postcompliance price increases determined above are inserted in the demand equations to provide changes in the demand forecasts. The difference between the baseline and the postcompliance simulations provides estimates of the changes in sales due to added costs of compliance with the effluent regulations.

2.2.6 Capital Availability Analysis

The capital availability analysis examines the ability of the copper forming plants to finance investments in new capacity and pollution control. The approach focuses on the ability of individual plants to finance pollution control and capacity expansion from current cash flow without relying on outside sources of capital. This assessment is based on the assumptions that the capital markets would provide the funds and the plant manager would invest in pollution abatement if the plant would still remain profitable after the investment. The capital availability analysis uses data on the cash flow, the investment, and the annual pollution control costs of individual plants to determine whether the plants can continue to be profitable after the required investment in pollution control.

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[4] A more detailed discussion of the derivation of the price impact formula is provided in Albert M. Levenson and B.S. Solon, Outline of Price Theory (New York: Holt, Rinehart and Winston, 1964), pp. 56-59.

Information on the cash flow for individual plants was estimated from data provided in the 308 Economic Survey. The cash flow for each plant was estimated as:

$$\text{Cash flow} = \text{net profits} + \text{depreciation} \tag{2.3}$$

Next, a capital budgeting approach is used to determine whether the plant can afford to install the required pollution control equipment. For each plant, the present value of the future stream of net income (cash flow) is calculated assuming that the plant invests in pollution control. The expected future cash flows of the plant are discounted back to the present year using an interest rate that reflects the plant's current cost of capital. The analysis takes into account the cash returns expected over the life of the plant and equipment, because the plant will remain open for many years if the operator invests to meet pollution control standards.

The plant will make the investment in pollution control if the expected future revenues are greater than the future annual expenditures, plus the capital investment in pollution control. The capital availability analysis is summarized in the following formula:

$$NPV = \sum_{\eta=1}^{\eta} \frac{CASH_{\eta}}{(1+i)^{\eta}} - \sum_{\eta=1}^{\eta} \frac{C_{\eta}}{(1+i)^{\eta}} - I \tag{2.4}$$

where

NPV = net present value

CASH η = cash flow over η periods

i = average cost of capital

C = annual pollution costs

I = capital investment in pollution control.

The decision rule is if the NPV is positive the plant would invest; if the NPV is negative or zero the plant could not afford to invest in pollution control. Furthermore, it can be assumed that if the firm could invest in pollution control and still remain profitable, then the financial markets would also be willing to finance the installation of the pollution control equipment.

The capital impact analysis uses the information provided by the copper forming industry 308 Economic Survey to calculate the expected cash flows for the individual plants. This analysis assumes that the cash flow of the plant will remain constant in real terms over the expected life of the plant (ten years). The estimated cost of capital over this period is 13 percent.

2.2.7 Plant Closure Methodology

A decision to close a plant is extremely complex, involving an array of factors, many of these subjective. Some of the more important factors to consider are:

- Present and expected profitability of the plant;
- Current market or salvage value of the plant, i.e., the opportunity costs of keeping the plant open;
- Required pollution control investment;
- Expected increase in annual costs due to pollution control requirements;
- Expected product price, production costs, and profitability of the plant after pollution control equipment is installed and operating; and

- Other major economic developments expected for the plant (i.e., change in the competitive position, increase/decrease in market growth).

Each of these factors is addressed to some extent in this plant closure analysis. Our efforts at this stage are aimed at identifying the plants that may close under the regulatory options.

In general a plant owner faced with pollution control requirements must decide whether to make the additional investment in pollution control or to sell the plant. A rational owner would decide to keep the plant if the before-and-after pollution control cash flows are greater than the salvage value of the plant. If the expected cash flows are less than the salvage value of the plant, the owner would be better off selling the plant. Since the plant will remain open for many years if the investment is made in pollution control, the analysis takes into account the cash flow expected over the life of the plant and equipment plus the salvage value at the end of the last period. The present value of future cash flows is calculated by discounting the expected income stream by the current cost of capital. The plant will remain open if the present value of the expected cash flows less the costs of investing in pollution control exceeds the expected salvage value. If the expected cash flows are less, the owner will sell the plant. Thus, the owner will close the plant if:

$$(2.5) \qquad S_o > \sum_{\eta=1}^{\eta} \frac{CASH_{\eta}}{(1+i)^{\eta}} - \sum_{\eta=1}^{\eta} \frac{C}{(1+i)^{\eta}} + \frac{S_{\eta}}{(1+i)^{\eta}} - I$$

where S_o is the current salvage value of the plant, S_η is the salvage value in year n, and the other variables are the same as defined in equation 2.4.

Plant specific financial data (i.e., profits, depreciation, and salvage value) were provided by the copper forming industry 308 Economic Survey. The annual cash flow of the plants is predicted to remain constant in real terms (i.e., increase at the level of the inflation rate) over the life of the plant and the cost of capital is estimated at 13 percent.[5] The investment and annual operating and maintenance costs for each of the pollution control options were determined in a separate study, which is described in the Development Document.

2.2.8 Employment and Community Impacts

The BAT effluent regulations may have both direct and indirect impacts on employment and the community. Direct employment impacts would result from plant closures; indirect employment impacts would result from price increases and the subsequent production decreases. Given the changes that may result from the regulation, these additional impacts can be estimated.

The estimate of employment effects flows directly from the outputs of the industry-level analysis and the plant closure analysis. The algorithms used are:

total employment impact = employment at closed facilities + $(Q_r)/(Q/\text{employee})$

Q_r = change in output which is due to the price increase associated with the compliance costs

Q/employee = baseline output produced per employee.

Community impacts result primarily from employment and earning losses. The critical parameters are the ratios of these variables to total employment and earnings in the community. Once these are established the multiplier effects on the community can be assessed. Data on community employment and earnings are available through the Bureau of the Census and the Bureau of Labor Statistics.

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[5] This cost of capital is based on an analysis of the capital markets and interest rate on treasury bonds.

2.2.9 Balance-of-Trade Impacts

The regulation would impact the balance of trade depending on (1) the extent that copper forming product prices in the domestic market rise faster than prices in the rest-of-world market and (2) the extent to which the domestic production losses are replaced by imports from foreign countries.

Information on both the price increases and output losses are determined in previous analyses. The effects from the effluent regulations on the trade balance are analyzed by evaluating the magnitude of changes in these variables. If the changes in these variables are negligible, then there would be no substitution of domestic products for imports (i.e., there would be no balance-of-trade impacts).

2.2.10 Small Entity Analysis

The Regulatory Flexibility Act (RFA) requires Federal regulatory agencies to consider small entities throughout the regulatory process. A small entity analysis of the copper forming industry is performed to determine if small entities would be significantly impacted by the effluent guideline and to ascertain if a regulatory flexibility analysis is needed for this industry. The definition of "small entity" is not precise or universal and several criteria (e.g., plant production, employment, wastewater flows) are examined for defining small plants in the copper forming industry. Since our analyses examine individual plants in the industry, some of which are small and some of which are large, a separate analysis for small business was unnecessary. The analysis of the impact on small businesses focused on a comparison between the impacts on small versus large plants to determine whether the small plants would be more significantly affected by the regulation than larger plants.

2.3 DATA

The economic analysis of the effluent regulation is based on information from several different sources. These include government reports, textbooks, trade association data, the trade press, discussions with individuals associated with the industry, and, of particular importance, a plant- and firm-level survey conducted by EPA under authority of Section 308 of the Clean Water Act (the 308 Economic Survey).

The 308 Economic Survey questionnaire was designed with consultation from representatives of the copper forming industry. The data collected in the survey provide accurate and current information on the economic and financial characteristics of the industry's plants and firms. Data collected included information on market structure, profitability, investment in new capital, value added, depreciation, and salvage value. These data, together with estimates of the costs of alternate pollution control options, served as the basis of the economic impact analysis of the proposed regulation for this industry.

The survey questionnaire was mailed to every known copper former.[6] A total of 105 plants (i.e., approximately 60 percent of all copper forming plants) responded to the 308 Economic Survey. The types of copper forming plants that filled out and returned the questionnaire included:

Brass Mills	
- Sheet and Plate	19
- Rod, Bar, and Mechanical Wire	14
- Tube and Pipe	16
- Combination Brass Mills[7]	5
Wire and Cable Mills	30
Other[8]	21
	105

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[6] Using a mailing list developed in cooperation with trade associations, 119 surveys were mailed out, many to corporate headquarters, with the instructions that the plant survey be forwarded to the corporation's applicable plants.

[7] Plants that produce two or more different types of products (e.g., sheet and plate and tube and pipe).

[8] The plants produced products other than brass and wire.

All questionnaires were returned directly to EPA by the respondents, and procedures were employed to protect the confidentiality of the data. These procedures included EPA's removing the identification section from each questionnaire and assigning a code number to each questionnaire before it was sent to the contractor for processing.

3. MARKET DESCRIPTION

This chapter provides an overview of the copper forming industry. It describes the main characteristics of the industry and the factors that may affect the growth of the industry's markets over the 1983-1985 period. Particular attention is given to end-use markets for copper products, substitution, foreign competition and price trends, because these factors determine the outlook, future competitiveness of the industry, and producers' ability to afford additional capital outlays for pollution control equipment.

3.1 INDUSTRY OVERVIEW

3.1.1 Industry Segmentation

The copper forming industry which employs approximately 43,000 employees consists of approximately 176 plants that form copper and copper-base alloys into intermediate and finished articles. This industry consists of two major groups--brass mills and wire mills. Table 3-1 provides information on the consumption of copper by the major copper using industries. In 1982 these two groups consumed about 86 percent of the approximately 2.6 million tons of copper.1/ Wire mills, which produce wire and cable products, accounted for approximately 52 percent of the total consumption of copper. Brass mills, which fabricate shapes such as sheet, strip, foil, plate, tube, pipe, and mechanical wire consumed approximately 34 percent of the total. Other industry segments include ingot makers and foundries. They accounted for approximately 7 and 3 percent, respectively, of the total copper consumed. The remaining 4 percent of U.S. copper consumption was accounted for by powder mills and a variety of other industries.2/

1/ Copper Development Association, Inc., Annual Data 1983.

2/ For purposes of this economic analysis, the copper forming industry includes only wire and brass mills. Other industries consuming copper may be covered by other regulations, e.g., the regulation on foundries covers copper foundries and copper ingot makers.

TABLE 3-1. CONSUMPTION OF COPPER IN THE UNITED STATES, 1982*

MARKET SEGMENT	COPPER CONTENT (In Thousands of Short Tons)	% TOTAL
Copper Formers		
Brass Mills	880.8	33.9
Wire Mills	1,356.4	52.2
Subtotal	2,237.2	86.1
Other Consumers		
Foundries	87.2	3.4
Powder Plants	16.6	0.6
Ingot Makers	177.6	6.9
Other Industries**	78.8	3.0
TOTAL	2,597.4	100.0

*Preliminary.

**Include chemical, steel, and aluminum industries.

SOURCE: Compiled by JRB Associates from the Copper Development Association, Annual Data 1983.

3.1.2 Production Processes

The copper forming industry is comprised of plants engaged in forming basic shapes (plate, sheet, strip, rod, tube, and wire) from cast forms, such as slabs, billets, and cakes. These plants employ a number of basic processes to form the copper or copper alloy, alter its mechanical properties, and change the condition of its surface. The basic forming operations are hot rolling, cold rolling, extrusion, drawing, and forging.

The wire mill segment is involved in drawing bare wire and the production of manufactured copper wire. Refined copper is heated, broken down by rolling or extrusion, and rolled into rods. The rods are then put through dies to make wire and cable of various sizes, ranging from thick electric power cables to hairlike wires for electronics equipment. Other wire mill products include high-voltage overhead electricity transmission cables, which are usually bare, and manufactured copper wire products, which are typically insulated with a variety of materials.

The brass mills segment of the copper forming industry consumes large amounts of copper scrap and refined copper. Brass mill products are made of both alloyed and unalloyed copper and can be grouped into three basic shapes: sheet, rod, and tube. The primary alloyed items, brass and bronze, are formed by melting scrap copper with primary copper and one of several possible alloying metals, such as zinc for brass and tin for bronze. Depending on the thickness to which they are rolled, brass sheets are classified as either plates or strips. Brass rods are produced by drawing and those that are subjected to additional drawing become mechanical wire (which is different from electrical wire). Brass tubes are produced by extruding copper in a variety of diameters, wall thicknesses, and configurations, including square and rectangular.

3.1.3 Production Trends

Table 3-2 provides information on various brass and wire copper forming products over the 1979-1982 period. This table shows that the production of brass and wire mill products dropped from a high of 6.1 billion pounds in 1979 to a low of 4.5 billion pounds in 1982. The record production in 1979 reflects the high price for copper products that resulted from speculative pressures and a strong demand for copper products in that year. These conditions, however, did not prevail over the next three years, although the market did show some slight improvement in 1981. The copper forming industry's output in 1982 was the lowest since the recession of 1974-1975, when the industry only produced 4.6 billion pounds of copper products.

The industry's poor performance in 1982 was a result of the prolonged period of high interest rates, the recession which depressed sales in the end-use markets (especially in the automobile and construction industries), and the excess world supply of copper. Production of copper forming products is expected to grow over the 1983-1990 period as the economy recovers and as sales in the end-use markets expand.[3]

3.2 END-USE MARKETS

The demand for copper forming products is a derived demand. Copper forming products are generally used in the production of final products and are not the final products themselves. For example, the housing, automobile, and electrical appliance industries use copper fabricated products to produce a variety of items such as radiators, heaters, and utensils. As a result, the demand for specific copper forming products depends on, and is influenced by, the behavior of key industrial sectors or end-use markets in the economy.

There are five major end-use markets for copper forming products. In order of importance the major market segments are:

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[3] See chapter 5 on the base-case projections.

TABLE 3-2. PRODUCTION LEVELS FOR THE DOMESTIC COPPER FORMING INDUSTRY
(In Millions of Pounds)

	1979	1980	1981	1982*
Brass Mill Products				
Sheet, Strip, and Plate	1,067	873	969	736
Mechanical Wire	111	79	81	59
Rod and Bar	970	816	818	621
Plumbing Tube and Pipe	483	414	401	369
Commercial Tube and Pipe	399	340	351	247
Total Brass Mill Products	3,030	2,522	2,620	2,032
Wire Mill Products				
Bare Wire	236	240	250	195
Communication Wire and Cable	971	850	854	755
Other Wire Products	1,867	1,708	1,768	1,475
Total Wire Mill Products	3,074	2,798	2,872	2,425
Total Industry	6,104	5,320	5,492	4,457

*Preliminary.

SOURCE: Copper Development Association, Inc., Annual Data 1983.

- Building and construction
- Electrical and electronic products
- Industrial machinery and equipment
- Consumer and general products
- Transportation equipment.

Table 3-3 shows copper consumption by major end-use markets in the United States from 1978 to 1982. A brief description of each of these end-use markets is given in the following paragraphs.

3.2.1 Building and Construction

The building and construction industry was the leading end-user of copper products in 1982. This segment consumed approximately 31 percent of the products manufactured by the copper forming industry. Most of the products used by this market are in the form of wire mill products. Copper has also been widely used for plumbing, roofing, and decorative items in public buildings and homes, largely because of its corrosion resistant properties.

3.2.2 Electrical and Electronic Products

The electrical and electronic products market segment was the second largest end-user of copper forming products in 1982, representing about 29 percent of domestic copper products consumption. Copper is a preferred material for applications such as electrical lighting, wiring, and cable because of its superior electrical conductivity and energy efficiency. Other applications include telecommunications equipment, electric motors, generators, and numerous miscellaneous electrical parts.

3.2.3 Industrial Machinery and Equipment

The industrial machinery and equipment end-use segment accounted for approximately 18 percent of the 1982 U.S. copper consumption. This market

TABLE 3-3. CONSUMPTION OF COPPER PRODUCTS BY MAJOR END-USE MARKETS*

	(In Millions of Pounds by Metal Weight)					
DOMESTIC MARKETS	1978	1979	1980	1981	1982**	% 1982
Building Construction	2,095	2,107	1,792	1,884	1,571	30.9
Electrical and Electronic Products	1,711	1,820	1,632	1,750	1,461	28.7
Industrial Machinery and Equipment	1,215	1,229	1,056	1,148	912	17.9
Consumer and General Products	930	994	823	806	653	12.9
Transportation Equipment	882	846	599	635	486	9.6
Total	6,833	6,996	5,902	6,223	5,083	100.0

*Products from wire mills and brass mills account for most of these totals, but products from foundries, etc., are also included.

**Preliminary.

SOURCE: Copper Development Association, Inc., Annual Data 1983.

segment uses brass and wire mill products in fittings, valves, bearings, screws, and pumps. Many of these parts are machined from extruded rod. Copper tubings in this market segment are used for heat exchangers in refrigerators, air conditioners, freezers, and water coolers.

3.2.4 Consumer and General Products

Consumer and general products accounted for approximately 13 percent of domestic copper use in 1982. This market segment consumes copper to manufacture durables such as washing machines, radios, televisions, phonographs, tape recorders, cutlery, watches, clocks, microscopes, projectors, and many types of gauges. Solid copper, brass, and bronze are also popular materials in utensils, furnishings, jewelry, and other decorative items.

Miscellaneous uses of copper forming products include shell castings, projectile fuses, and rotating bands for ordnance. Copper also has important applications in coinage in the United States.

3.2.5 Transportation

In 1982 the transportation equipment sector accounted for 10 percent of U.S. copper consumption. This industry segment uses copper in automobile, truck, airplane, railroad, and marine components. For example, the automobile industry alone uses approximately 25 pounds of copper per vehicle. Most of this goes into radiators, air conditioners, power windows, seats, and brakes. Copper is also used in producing heaters, defrosters, bushings, carburetors, oil lines, and wiring in cars and other vehicles. Large quantities of copper are used in diesel locomotives, railroad passenger cars, and switching and signal devices.

3.3 TECHNOLOGICAL CHANGE AND SUBSTITUTION

The growth in the demand for copper forming products is influenced by factors other than price and the end-use markets. These factors include:

- Direct substitution of one material for another
- Technical change in end-use markets
- More efficient use of copper.

Each of these activities affect the demand for copper and is considered here to establish factors other than the regulation which may affect the industry over the regulatory impact period.

3.3.1 Direct Material Substitution

Direct substitution of copper forming products from materials such as aluminum, plastic, and steel is widespread. Aluminum has made great inroads into traditional copper markets because of its similar properties, its lighter weight, and its lower cost. The greatest replacement of copper by aluminum has been in the transmission of electricity at high voltages. Some 40 percent of the insulated power cable and over 90 percent of bare conductor applications are now provided by aluminum.[4/] Because of its weight advantage over copper. aluminum-conductor, steel-reinforced cable has been used for most long-distance power transmission lines for more than a decade. Aluminum alloys are also being used as conductors on overhead transmission lines.

In the building industry, substitution of aluminum for copper has also been increasing. The degree of substitution is directly related to the size of the wire, i.e., the larger the wire, the greater the percentage of aluminum building wire used. Substitution of aluminum for copper in small building wire has been hampered because of safety problems in residential applications. At current prices copper still remains the first choice for automotive wiring. In areas where space in an existing design is not a problem, the use of the larger sizes of aluminum wire will increase. Examples of such applications

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[4/] Bureau of Mines, Mineral Commodity Profiles, Copper, September 1979.

are battery cables, air conditioners, clutch coils, alternators, anti-skid devices, horn coils, and some accessory motors.[5]

In addition, copper and aluminum are mutually interchangeable in some heat exchanger applications. Copper has been used predominately in this area because of its heat-transfer properties, corrosion resistance, ease of fabrication, and ease of joining the various components by conventional soldering techniques. The largest use of copper in this area, automobile radiators, is vulnerable to aluminum. However, the inability to repair aluminum radiators is inhibiting widespread application. Copper tubing is still the predominant primary surface in heat exchangers for commercial refrigerators and freezers, and for room, central residential, and commercial air conditioners. Aluminum tubing is used in less than 10 percent of these products. Aluminum alloy tubing in air conditioners may have twice the wall thickness of copper, but still maintains a weight and cost advantage. However, extensive manufacturing development would be necessary before aluminum could completely replace copper in these applications. Other substitutes include plastics which have replaced copper in many plumbing applications.

3.3.2 Technological Change in End-Use Markets

Technological substitution has also significantly impacted the demand for copper. The most obvious development is that of microwave technology and communication satellites, which have substantially reduced the demand for undersea and long-distance copper cables. Current developments in fiber-optic transmission technology for intracity communication transmission lines may reduce or eliminate much of the market for copper wire products over the long run. Recent uses of this new technology include a 633-mile fiber-optic system connecting Sacramento and San Diego by Pacific Telephone and Telegraph. The

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[5] Raymond F. Mikesell, The World Copper Industry (Baltimore: Johns Hopkins University Press, 1979), pp. 160-163.

Bell System has begun to install various fiber-optic systems. AT&T has announced its plans to install 1,000 miles of fiber-optic cable within the next three years, replacing the equivalent of 2,000 tons of copper.

3.3.3 More Efficient Uses of Copper

The demand for copper forming products has also been affected by the more efficient uses of copper. For example, improved copper alloys have made it possible to make thinner walled copper tubing, with the result that it requires substantially less copper to produce a foot of copper tubing of the same inside diameter today than it did ten years ago. Automobile radiator walls today are made thinner, thus reducing the amount of copper used in radiators.

3.4 IMPORTS AND EXPORTS

Historically, the balance of trade in copper forming products has been unfavorable to the United States. Domestic producers have little incentive to develop an export market for their fabricated products primarily because of subsidized production, tariff and nontariff barriers, and low costs of labor and copper in foreign countries. As a result, the U.S. copper formers have concentrated their marketing efforts on domestic customers.

In 1980 the competitive trade position of U.S. domestic suppliers in the world changed drastically indicating the possibility of substantial improvements in the trade balance. As shown in table 3-4, imports of copper mill products dropped by 44 percent over the 1978-1980 period, from 492.6 million pounds in 1978 to 294 million pounds of copper mill products in 1980. Meanwhile exports increased by approximately 50 percent, from 209.4 to 312 million pounds over the same period. Thus, the trade deficits of 283.2 and 187 million pounds in 1978 and 1979 changed to a surplus of 18 million pounds of copper in 1980. Brass mill products accounted for the largest relative share of imports and the lowest relative share of exports (see figure 3-1). On the average, imports of brass mill products have been three times as great as

TABLE 3-4. IMPORTS AND EXPORTS OF COPPER FORMING PRODUCTS, 1970-1980
(In Millions of Pounds)

YEAR	IMPORTS	EXPORTS	TRADE BALANCE*
1970	202.4	69.9	-132.5
1971	249.2	77.9	-171.3
1972	297.7	84.3	-213.4
1973	308.7	127.8	-180.9
1974	257.6	161.4	-96.2
1975	195.3	137.1	-58.2
1976	353.5	130.1	-223.4
1977	359.4	165.5	-193.9
1978	492.6	209.4	-283.2
1979	436.0	249.0	-187.0
1980	294.0	312.0	18.0
1981	492.8	284.4	-208.4
1982**	391.9	206.3	-185.6

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*Calculated by JRB Associates from import and export data in the Copper Development Association, Inc., Annual Data 1983.

**Preliminary.

SOURCE: Copper Development Association, Inc., Annual Data 1983.

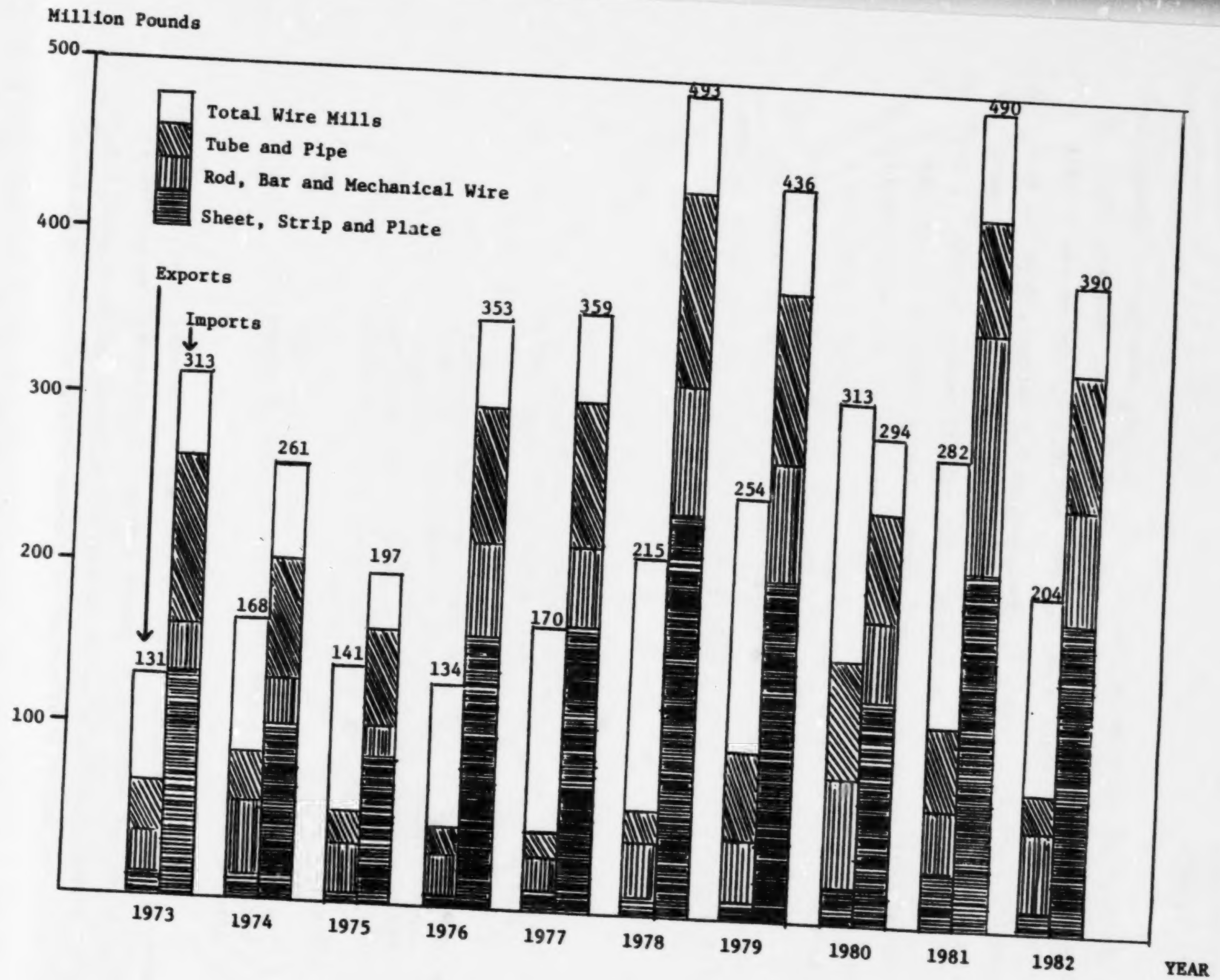

FIGURE 3-1. U.S. EXPORTS AND IMPORTS OF COPPER FORMING PRODUCTS*

*The data were compiled by JRB Associates from statistics in the Copper Development Association, Annual Data 1983.

exports, and exports of wire mill copper products were four times greater than imports in 1980.

The changes that occurred in 1980 appear to be only momentary. Imports of copper mill products in 1981 went up by almost 67 percent over the 1980 level, moving from 294 million pounds in 1980 to 490.1 million pounds in 1981. Simultaneously, exports decreased by approximately 7.5 percent, from 312 million pounds in 1980 to 288.5 million pounds in 1981. As a result, the trade surplus of 1980 turned into a deficit of 201.6 million pounds in 1981. Brass mill products still accounted for the largest relative share of imports and the lowest relative share of exports. In 1981 exports of wire mill products were three and a half times as large as imports. Significant changes worth noting in the 1980-1981 period are: (1) the imports of brass mill products almost doubled, moving from 248.1 to 442.6 million pounds and (2) exports of brass mill products fell almost 15 percent, moving from 139.1 to 120.6 million pounds. The key factors that led to the recent balance-of-trade deficits include:

- The worldwide recession which reduced the demand for copper products in the developed and developing countries and led to a fall in the world market price of copper;
- Market strategies of government-owned and -operated copper producing operations in developing countries that focus on maximizing foreign exchange earnings and employment rather than profits. These countries continue to produce and export their copper products even in depressed markets; and
- The rise in the value of the U.S. dollar which has encouraged imports and discouraged exports of copper forming products.

The adverse trade balance is likely to continue for several years, especially if the U.S. dollar continues to remain strong. Furthermore, as additional low-cost copper capacity comes on stream in the developing countries, U.S. copper producers may find it harder to compete effectively in the domestic and overseas markets.

3.5 PRICES

3.5.1 Industry Price Determination

Historically, copper forming products were marketed at prices based on two major price systems. One system consisted of producer prices set independently by major primary producers in the United States and Canada. The second price system consisted of prices related to quotations on a metal/commodity exchange. The London Metal and the New York Commodity Exchanges (LME and COMEX) are two organized metal exchanges (markets) where most international copper trading occurs.

U.S. producers have traditionally sold their products at their published prices. These producer prices were influenced by the COMEX and LME copper prices, but they remained relatively stable over long periods of time. Generally, producer prices moved slowly and at times were above or below the exchange or "outside market" price. During periods of strong demand, U.S. producers tended to change their prices slowly and not by the magnitude often experienced by the COMEX/LME prices. As a result, the producers' prices have generally remained well below those set by the "outside market." This practice gave their customers an advantage on raw material costs and retarded substitution of copper by other materials. During periods of weak demand, domestic U.S. producer prices were usually higher than the metal exchange market prices as producers attempted to recover their costs of production.

This pricing behavior resulted in the existence of a two-tier price system for copper products which was characterized by a wide divergence between the "outside market" price for copper (i.e., the LME price) and the domestic producer price. This system seemed to work as long as the market did not weaken. However, since 1975, a combination of factors appears to have had substantial restraining influence on the pricing decision of the domestic primary producers. Between 1975 and 1978, the world copper market weakened, and "outside market" prices, or imported prices, fell substantially below those of the U.S. producers. An increasing number of U.S. copper consumers switched their purchases to the lower priced copper fabricated product imports. This situation climaxed in the new producers' price policies of mid-1978 when key U.S. producers decided to base their prices on the daily quotes of COMEX. Since 1978 Kennecott Copper and Anaconda Co. have based their spot prices on the daily quotes of the nearest copper futures contracts on COMEX, plus a fixed premium. Other producers have maintained a fixed-price system, but competitive forces have compelled them to change their quotes very frequently. In effect, most companies' prices have become very responsive to changes on the commodity exchange.

3.5.2 Recent Copper Price Trends

In February 1980 copper prices reached a high of $1.45 per pound. This high price resulted from (1) the significant decline in copper stockpiles in 1979 and (2) speculation in a number of metals markets in early 1980. However, by early April 1980 major producers were charging $0.91 to $0.95 a pound for refined copper, down from February's (1980) domestic high of $1.45. This downward trend continued during the 1981-1982 recession. U.S. producer prices during 1982 averaged $0.74, down 12 percent from the average 1981 price. The major factors influencing this price drop in 1982 included:

- The worldwide recession;
- The tight money policy of the Federal Reserve which kept interest rates high; and
- Increase in overseas copper producing capacity.

We can expect increases in the price of copper products as the interest rates fall and the economy recovers. Both of these factors will increase the demand for copper products and as the large inventories of copper products decline the price should begin to rise.

3.6 SUMMARY OF MARKET DESCRIPTION

The analysis suggests that the copper forming industry is involved in producing products that are very sensitive to the behavior of the overall economy. In periods of expansion, the industry's end-use markets expand and the supply, demand, and prices for copper forming products increase. On the other hand, during periods of recession and high interest rates, the end-use markets contract and the output, demand, and prices of copper products fall. Substitution from other products and new technologies do exist, but they are not significant enough to reduce the growth of the copper industry market. In 1980 the export of wire mill products increased while imports of some copper forming products stabilized or decreased slightly. However, this trade surplus reversed back to a trade deficit in 1981 and 1982, as the U.S. dollar strengthened and world prices fell. There are indications that the economy is experiencing a recovery from the 1981-1982 recession. This would stimulate the production of domestic copper products in the future, as the demand and price situation improves.

4. INDUSTRY STRUCTURE AND PERFORMANCE

4.1 OVERVIEW

The impact of the effluent limitations and standards on the copper forming industry will be influenced by the industry (market) structure and prevailing market conditions. In general, the performance of a firm (participant) in an industry is determined by the conduct (i.e., the pricing and production strategies) of the firms in the market. The firm's market conduct is, in turn, dependent upon the market structure and business conditions prevailing at the time. Certain market structures (e.g., monopoly) imply that the participants have control over the market and can set prices and quantity in such a way that profits are maximized. Consequently, the monopolist would be expected to have higher profit margins and would be able to absorb added costs with less financial difficulty than other firms (i.e., firms in competitive markets).

This chapter examines the market structure, conduct, and financial performance of the copper forming industry. The results of this examination are used in chapters 5 and 7 to estimate how the industry would behave when faced with the decision to invest in the recommended pollution control equipment. The various types of industry structure and their role in determining economic impacts are discussed. The observed market structure of the copper forming industry is described and key financial ratios are analyzed to establish the profitability and capital structure of the industry.

4.2 TYPES OF MARKET STRUCTURES

The range of market structures is bound by perfect competition and monopoly. The perfectly competitive industry is characterized by:

- A very large number of participants (buyers and sellers) where each participant accounts for an imperceptible share of the market

- A homogeneous or standardized product

- Participants that are well informed about product quality and each other's prices

- Relatively easy exit and entry into the industry.

In a perfectly competitive market no individual firm has influence over the market price. The price is given to the firm and the firm decides only how much to produce and sell at the prevailing price. Because each firm's output is an imperceptible part of the total output of the industry, output decisions have no influence on the market price. Also, since the products of the firms are perfect substitutes for one another, the price elasticity of demand facing the firm is infinite. For these reasons, the price that the firm observes is determined by the interactions of supply and demand forces in the entire market where all firms participate.

The market structure at the other end of the spectrum is monopoly, which is characterized by:

- One firm in the industry
- No close substitutes for the product
- Substantial barriers to entry.

The latter characteristic is important for the maintenance of monopoly power in the long run. Barriers to entry must exist if the monopolist can remain the sole producer of goods in the long run, while at the same time earning large profits which induce entry. Barriers to entry may exist because of (1) weak demand conditions, (2) control of raw materials by one firm, (3) legal and institutional factors imposed by governments, (4) scale economies that satisfy the entire market, (5) large capital requirements, and (6) the lack of technological expertise by outsiders.

In general, the monopolist can fix price and let demand conditions determine output or he can fix output and let demand conditions determine price. He maximizes his profits at the output at which his marginal revenues equal marginal costs. For any given quantity of output sold, the marginal revenues and costs will be less than price, because the demand curve of the industry slopes downward. By way of contrast with the perfectly competitive firm, the monopolist may (1) charge a higher price, (2) produce fewer units, and (3) operate a less than optimal scale plant.

Between these two extremes are other forms of market structures. Closely related to the perfectly competitive market is monopolistic competition. This market structure is associated with industries in which there are a great number of firms, but the product is somewhat differentiated (e.g., the toothpaste industry). As a result, the demand facing the individual firm is not perfectly elastic, but its price elasticity is high due to the existence of close substitutes produced by other firms in the industry. Firms in this market attempt to create separate markets for their products through advertising and product design, in order to have some control over their price and output decisions. To the extent that they can create a separate market for their products, their price will be higher and their output lower than under a perfectly competitive market structure. Unlike monopoly, which has significant barriers to entry, monopolistic competition has insignificant barriers to entry.

Another market structure within this spectrum is the oligopolistic market, which is characterized by a few sellers. There are at least five different types of oligopoly models that are recognized in the economic literature. However, the characteristic that is common to them all is their small numbers which force them to recognize the interdependence of their activities. One seller recognizes that his actions affect other sellers and the other sellers are likely to react in some fashion to his activities. Since there is no way to determine, *a priori*, the interactions that may result because of a decision, the market solutions to this type of market structure are indeterminate.

The pricing behavior of this market structure is sometimes characterized by price leadership and followership, by long periods of stable prices, or by periods of price wars to capture market share. The airline industry provides a good example of this type of market structure.

Market structure influences pricing policy in an industry and, hence, the financial condition and performance of individual firms in the industry. In a perfectly competitive market, firms realize normal profit, i.e., profits approach the market rate of interest plus a premium for the risk associated with that business. In a monopoly market, the firm has market power and can earn a greater profit than under perfect competition. The profits of the firms in the other market structures are somewhere between these two market extremes.

4.3 MARKET STRUCTURE OF THE COPPER FORMING INDUSTRY

Market structure can be assessed by evaluating the following four factors: (1) buyers and sellers concentration, (2) vertical integration, (3) product differentiation, and (4) ease of entry into the industry.[1] Each of these factors in turn affect the individual firms' performances and price/output decisions.

4.3.1 Conceptual Problems in Determining Market Structure

It is difficult to analyze the financial condition and performance of participants in the copper forming industry in a precise manner because of the heterogeneity of the units (i.e., diverse nature and size) and because of the ownership relationships. The problems arise because some of the participants are subsidiaries of large corporations that are involved in producing and selling products unrelated to copper forming (e.g., oil companies). Others are involved in earlier stages of copper manufacture such as mining, smelting, and refining. To overcome these problems and alleviate some of the biases that these conditions create in analyzing the performance of the participants in the copper forming industry, the analysis was disaggregated into three broad categories--corporate, reporting entity, and plant. This grouping provides a more precise definition of the participants in the industry and allows for a meaningful analysis of the financial condition of the industry.

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[1] James V. Koch, Industrial Organization and Prices (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1974).

The financial condition at the corporate level provides information on the overall economic and financial viability of all the entities that make up the corporation and its ability to incur debt or finance new investment in plant, machinery, and equipment. At this level, the analysis is not concerned with the copper forming manufacturing facility, per se. It is mainly concerned with the overall financial picture of the entire company, whether it be a copper producing company or an oil conglomerate that owns a copper forming plant.

The analysis at the reporting entity level provides information on the financial condition of the unit to which individual copper forming plants report directly. The unit is defined as the management structure that most clearly reflects copper forming operations and only copper forming operations. This unit may be a subset of the parent corporation which may also be involved in other businesses (e.g., an oil conglomerate may own several copper forming plants which are managed by a separate unit--the reporting entity). At this level of analysis the unit or reporting entity that is most closely related to the copper forming plants is identified and analyzed.

Finally, the analysis at the plant level examines the profitability of individual copper forming plants. The disaggregation at this level is important because it is doubtful whether a corporation (whether a copper company or an oil company) would continue to subsidize and/or invest further in a sector of its organization that was not making profits over the long run, even though the parent company was making large profits or had the cash flow to invest in pollution control capital equipment.

4.3.2 Industry Concentration

A measure of the industry concentration provides information on the number and size distribution of sellers in the market. It indicates how much of the market sales (or some other unit of output measurement) is held by a portion of firms in that market. For example, it provides the percentage of sales accounted for by the 4, 8, 20, and 50 largest firms in that market. Generally, when concentration is low, there is a large number of firms, and each individual firm's share of the market will be so small that no individual firm would be able to influence prices significantly (i.e., firms are price takers, not price setters). On the other hand, in markets where concentration is high, the pricing and production decisions of any one firm will have some effect on the pricing and output of other firms in the relevant market. Consequently, price and output determination by the firms will be interdependent.

Table 4-1 summarizes concentration ratios for the copper forming reporting entities and corporations (including single-plant firms) responding to the 308 Economic Survey.[2] Based on this survey, the largest four reporting entities in 1979 accounted for approximately 52 percent, and the largest eight reporting entities accounted for 74 percent of sales in the industry.

Although the concentration ratios at the reporting entity level are higher than those of some manufacturing industries such as apparel and electronics, they are low compared to other manufacturing industries, such as automobile, steel, and even other stages of copper manufacture. For example, six companies in the copper refining segment controlled over 90 percent of the U.S. refining capacity in 1973.[3] Considering that the concentration ratios for the entire

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[2] The concentration ratios shown in the table are greater than those for the entire copper forming industry because they are calculated from the survey responses which do not include the entire industry.

[3] Raymond F. Mikesell, The World Copper Industry (Baltimore: Johns Hopkins University Press, 1979), pp. 31-33.

TABLE 4-1. INDUSTRY CONCENTRATION RATIOS

NUMBER OF PARTICIPANTS	REPORTING ENTITY***		CORPORATION INVOLVED IN COPPER FORMING	
	CONCENTRATION RATIO (%)	CUMULATIVE 1979 SALES* ($000)	CONCENTRATION RATIO (%)	CUMULATIVE 1979 SALES* ($000)
Top 4	51.7	2,965,620	69.4	32,709,911
Top 8	73.9	4,237,793	82.1	38,706,266
Top 16	93.3	5,352,251	96.0	45,267,312
Total**	100.0	5,737,039	100.0	47,161,297

*Not all of the sales of these reporting entities and corporations are due to copper sales.

**A total of 41 reporting entities and 43 corporations.

***"Reporting entity" for purposes of this analysis is defined as the management structure that most clearly reflects copper forming operations and only copper forming operations. Some plants report directly to a corporation and the data from that corporation may not properly be considered data from a "reporting entity" because the corporation may include non-copper forming operations.

SOURCE: Compiled from data provided in the 308 Economic Survey.

industry (including nonrespondents to EPA's industry survey) would be lower, the industry's concentration ratios do not strongly support the hypothesis that noncompetitive market conditions exist.

4.3.3 Integration

The degree of integration is an important determinant of the industry's conduct and performance. For example, in a firm that is highly vertically integrated, material costs may be somewhat insulated from the market demand forces at intermediate stages of production. This does not mean that producers, in making price and output decisions, can ignore market forces. Rather, it means that producers have control over some, but not all, of the relevant demand forces emanating from downstream markets.[4]

In addition, the existence of a high degree of integration in a particular market can constitute an effective barrier to entry into the industry. For example, a potential entrant to the copper forming stage could face a dilemma if most of the existing firms are highly integrated. Suppose that a firm enters the copper forming industry when 90 percent of the production of both copper ingots and copper forming products are controlled by vertically integrated firms. If the firm buys from a nonintegrated ingot producer, the copper forming firm can depend on only 10 percent of the industry's ingot capacity and might find itself dealing in a thin market. The entrant avoids this problem, of course, if the firm enters as an integrated producer. But that strategy may not be possible if one or more of the production stages is large-scale and capital intensive. The entrant must choose between the costs of integrated entry (high capital investments in fixed assets) and the risks of unintegrated entry so as to minimize his disadvantage. The existence of such barriers to entry into the industry is important as it affords opportunities for firms in the industry to indulge in the noncompetitive pricing behavior and production behavior of the existing producers.

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[4] Buyer concentration is important because copper fabricated products are intermediate goods rather than goods going to final consumers. In times of recession, strong buyers can force prices below average costs.

Several of the domestic primary producers participate either directly or through subsidiaries in all five stages of production: mining, milling, smelting, refining, and fabrication (i.e., copper forming). The principal domestic producers such as Anaconda (ARCO), Inspiration, Kennecott (Standard Oil of Ohio), ASARCO, Magma, Phelps Dodge, and White Pine are all integrated. Of these, Phelps Dodge, ASARCO, Kennecott, and Anaconda control copper forming facilities that account for 50 percent of domestic copper consumption. This is a high level of integration but may not be an overriding influence on price and output decisions because of the existence of significant capacity at other domestic and foreign independent producers and because of other market factors discussed below.

Kennecott, the largest U.S. copper producer, is vertically integrated downstream into copper forming through its wholly owned subsidiary, Chase Brass and Copper. Atlantic Richfield Co. (ARCO) participates through Anaconda Minerals, which mines copper, and Anaconda Industries, which fabricates brass sheet, strip, and tube. These subsidiaries consume more copper than is produced by Anaconda. Phelps Dodge produces wire, wire rod, and copper tubes at facilities that consume about 30 percent more copper than the primary production at Phelps Dodge. Similarly, Cities Service owns New Haven Copper and Chester Cable; Cyprus mines (AMACO) owns Cyprus Wire and Cable; and El Paso Natural Gas owns Narragansett Wire. While ASARCO does not own copper forming capacity directly, it owns 33 percent of Revere.[5]

The copper forming divisions, subsidiaries, and affiliates of the major copper producers are believed to account for roughly 35 to 55 percent of the total copper forming capacity. Of the three major producers, Anaconda appears to consume the highest percentage of its own copper, Phelps Dodge the next highest, and Kennecott the least. However, the vagaries of the market from year to year and the fact that companies buy and sell to and from each other complicate the picture.[6]

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[5] Economic Impact of Environmental Regulations on the United States Copper Industry (prepared for the U.S. Environmental Protection Agency, Washington, D.C., by Arthur D. Little, Inc., January 1978), p. III-24 and Copper, Supplement to American Metal Market, September 28, 1981, p. 8A.

The degree of integration in this industry influences the price-output decisions of the companies in several ways. For example, integrated companies consider the copper forming stage an outlet for the primary copper produced. For this reason, companies have typically endeavored to maintain low prices on copper forming products, relying on the sale of the primary metal for the bulk of their profits. The largest expense for most independent copper formers is the cost of copper; thus, profitability depends substantially on the copper former's markup or spread. As a result, there is often a struggle in the market. The integrated producers seek to keep product prices on their copper forming products low enough to boost demand and provide an expanding market for the more profitable primary and refined output, while the independent copper formers strive to raise their prices and margins. Both groups prosper in a high demand-high price market such as in 1974, but independents suffer less in recessionary period-low price markets such as in 1975, because they can benefit from the lower raw materials costs. During recessions the integrated producers can have substantial sale and earning losses because of their high fixed costs and reduced operating rates, as well as reduced prices.

4.3.4 Product Differentiation

Product differentiation is an important determinant of market share and price/output decisions in some industries. Some firms may significantly influence their profit margins by differentiating their products (i.e., by creating separate markets) which enhances their market share or provides them with the market power to raise prices. However, product differentiation does not play an important role in the copper forming industry. Copper forming products are relatively homogeneous, in that they have well-defined physical and performance properties that conform to generally accepted standards in the industry. For this reason, copper formers' efforts in advertising and product differentiation are small.

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[6] Economic Impact of Environmental Regulations on the United States Copper Industry, op. cit., p. IV-13.

4.3.5 Barriers to Entry

A barrier to entry is simply any advantage held by existing firms over those firms that might potentially produce in a given market. Examples of barriers to entry include the control of sources of key raw materials by existing companies, large capital and technological requirements, the cost and source of financing investment, and vertical and horizontal integration of existing companies.[7] For example, the size of the investment that is necessary to construct a nuclear power plant and the technology that is required by individuals entering that area may be significant deterrents to entry.

As described in section 4.3.3, vertical integration and access to captive sources of raw materials represent only minor potential barriers for copper formers. Moreover, this industry is not as capital intensive as other manufacturing industries or other stages of copper manufacturing, such as smelting and refining. For these reasons, barriers to entry into the industry are not a significant factor in price determination for copper forming products.

Another factor that has affected the copper forming market structure is the increasing number of new firms and the growing level of production in foreign countries. In recent years foreign countries have been moving into the downstream stages of copper manufacturing and building copper forming and processing plants near the source of the raw material. However, because of the growing demand for copper products abroad and the change in pricing policies of U.S. copper formers over the past four years, the impacts of these overseas developments have been mitigated to some degree.

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[7] J. S. Bain, Industrial Organization (New York: John Wiley and Sons, 1968), pp. 251-301.

4.3.6 Summary of Industry Structure Characteristics

After reviewing the four basic industry structure measures, it can be inferred that this industry is characterized by (1) relatively moderate four-firm and eight-firm concentration ratios; (2) a moderate degree of vertical integration which has some, but not overriding, effects on market price formations; (3) a low degree of product differentiation; and (4) moderate entry requirements. For these reasons a relatively high degree of competition exists among the participants of this industry.

As discussed in section 4.2, competitive industries are expected to earn "normal" rates of profit. Thus, review of industry financial ratios serves a useful function of checking the conclusions regarding market behavior. In the next section, the financial performance of the industry is examined and found to support the conclusion that a fairly competitive market structure operates in the industry.

4.4 FINANCIAL PERFORMANCE OF THE COPPER FORMING INDUSTRY

This section describes the financial condition and performance of participants in the copper forming industry. The financial analysis focuses on measures of profitability, capital structure, and productivity. Measures of these variables provide information on the financial status of the participants in the copper forming industry and whether they can raise the required capital for expenditures in pollution abatement equipment, from retained earnings (internally), or from stock or bond markets (externally). Furthermore, they provide indicators of the financial viability (including plant closure potential) of participants under present circumstances, and in the event of the EPA effluent regulation being imposed.

The analysis examines the actual performance of 43 copper forming corporations[8] and 41 reporting entities[9] that operate 105 copper forming plants. Key financial ratios for the participants in this industry are evaluated over time by entity and firm size. Evaluating the data over a period of time is important because it mitigates the potential for distortions caused by unusual years when losses or gains may have been large. Reviewing the data by entity size provides information on whether size plays an important part in determining performance, i.e., whether economies or diseconomies of scale exist. The information in this section also provides useful benchmarks for comparing the performance of individual participants later in the analysis of high impact plants.

4.4.1 Financial Status of Copper Forming Companies

4.4.1.1 Profitability at Corporation Level

Table 4-2 provides a summary of profitability measures for the corporations involved in copper forming. The data suggest that the performance of the corporations as a whole has been poorer than that of related industries. Over the period of analysis, the profit margins after taxes increased slightly from about 2 percent in 1976 to 2.5 percent in 1979. The returns on net worth (equity) and assets after taxes were low but showed steady improvements over the 1976-1979 period. The industry averages for these two financial measures increased from approximately 8.5 and 7.4 percent in 1976 to 11 and 10.3 percent in 1979, respectively. Despite the recovery during this period, the

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[8] For purposes of this analysis, copper forming corporations include not only oil corporations and other conglomerates whose subsidiaries include copper formers but also smaller corporations whose only operation is copper forming.

[9] "Reporting entity" for purposes of this analysis is defined as the management structure that most clearly reflects copper forming operations and only copper forming operations. Some plants report directly to a corporation and the data from that corporation may not properly be considered data from a "reporting entity" because the corporation may include non-copper forming operations.

TABLE 4-2. KEY PROFITABILITY RATIOS FOR CORPORATIONS PERFORMING COPPER FORMING
(Percentage)

CORPORATE-LEVEL FINANCIAL RATIOS	1976	1977	1978	1979
Profit margin before taxes (returns on sales)	4.12	4.54	4.64	5.74
Profit margin after taxes (returns on sales)	1.96	2.33	2.70	2.49
Return on equity before taxes	17.17	16.30	20.06	23.62
Return on equity after taxes	8.46	9.30	13.37	11.01
Return on assets before taxes*	14.86	14.01	15.24	24.13
Return on assets after taxes*	7.41	7.09	8.82	10.31

* Fixed assets.

SOURCE: Compiled by JRB from data provided in the 308 Economic Survey.

profitability of the corporations involved in copper forming is still below the average of the total fabricated metal products industry. The profit margin and return on equity after taxes for the fabricated metal products industry as a whole in 1978 were 4.7 and 16 percent, respectively.[10]

Table 4-3 shows the four-year average profitability ratios for these corporations disaggregated by size. The data reveal that the the profit margin after taxes for the large corporations is 4.5, compared to 2.5 for all corporations involved in copper forming. The return on equity and return on assets, however, show mixed results. Return on assets for large corporations is significantly greater than for small ones, but the reverse is true for return on equity. Larger firms appear to have higher profit margins but lower asset-turnover rates. Other than these observations, there does not appear to be a direct relationship between profitability and size. The superior performance of the larger corporations may not necessarily reflect the performance of large firms in the copper forming segment, per se, because the larger firms are generally conglomerates including such businesses as petroleum and coal, and copper forming is only a subsidiary. The analysis at the reporting entity level (section 4.4.2) provides further insights into profitability and whether size plays a part in the performance of the copper forming segment of these companies.

4.4.1.2 Capital Structure Analysis at the Corporation Level

The capital structure is examined to provide information on the ability of the corporations involved in copper forming to finance initial capital outlays. Six key ratios that provide a profile of the industry debt structure, leverage, and ability to finance current debt are summarized in table 4-4. The first measure, the debt coverage ratio, is the ratio of net profits before interest and taxes to interest expense. Based on the 308 Economic Survey data, this ratio is high for the industry as a whole. A high ratio suggests that the corporations are able to service their debts in the near term.

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[10] Federal Trade Commission, Quarterly Financial Report for Manufacturing, Mining and Trade Corporations, First Quarter 1979.

TABLE 4-3. KEY FINANCIAL RATIOS FOR CORPORATIONS BY SIZE CATEGORIES, 1976-1979*
(Percentage)

TOTAL CORPORATE SALES (MILLIONS** OF 1979 DOLLARS)	PROFIT MARGIN†		RETURN ON EQUITY		RETURN ON ASSETS††	
	BEFORE TAXES	AFTER TAXES	BEFORE TAXES	AFTER TAXES	BEFORE TAXES	AFTER TAXES
Very Large $10,000+	7.95	4.45	20.66	11.62	19.76	10.90
Large $9,999 - $1,000	5.32	2.65	18.62	8.81	22.65	11.14
Medium-Large $999 - $100	5.35	2.70	13.43	6.09	12.74	6.45
Medium $99 - $20	4.63	2.53	22.85	16.46	21.74	7.36
Medium-Small $19 - $5	3.15	1.99	22.98	10.29	14.79	8.52
Small under $5	3.05	1.90	23.67	16.35	14.41	9.06
Total	4.62	2.50	19.47	10.75	16.99	8.43

*Average over the 1976-1979 period.

**Sales are not exclusively from copper forming but include sales from other corporate activities.

†Return on sales.

††Fixed assets.

SOURCE: Compiled by JRB Associates from data provided in the 308 Economic Survey.

TABLE 4-4. KEY CAPITAL STRUCTURE FINANCIAL RATIOS OF CORPORATIONS INVOLVED IN COPPER FORMING
(Percentage)

CORPORATE LEVEL FINANCIAL RATIOS	1976	1977	1978	1979
Debt coverage ratio	697.88	680.33	850.28	931.36
Long-term debt/total capitalization	31.39	33.90	36.60	33.68
Debt/equity	51.78	54.62	67.33	64.49
Capital expenditures/sales	3.90	5.35	4.99	4.79
Pollution capital expenditures/sales	0.93	0.66	0.41	0.37
Assets/sales	40.28	41.39	37.22	32.80

SOURCE: Compiled by JRB from data provided in the 308 Economic Survey.

The debt/equity and the long-term debt/total capitalization ratios provide measures of credit-worthiness and financial risk involved in the manufacture of copper forming products (see table 4-4). The debt/equity ratio provides a measure of debt to net worth of the corporation, while the long-term debt/total capitalization provides a measure of the long-term capital structure of the corporations. These ratios indicate that the industry debt structure has been deteriorating since 1976. In 1979 the debt/equity ratio of the corporations reached 64.5 percent.

The fourth parameter, the capital expenditures to sales ratio, is relatively low for the industry. This is expected because of the slow growth of this industry and the longevity of the capital equipment. Investment in other pollution abatement equipment, the fifth parameter, is also low for the industry as a whole. Since 1976 there has been a decline from 0.9 percent of sales for these types of expenditures to 0.4 percent of sales in 1979. The assets to sales ratio, the sixth parameter, is high, but there are indications that the industry as a whole has been utilizing its assets in a more efficient manner over the four-year period. The assets/sales ratio dropped from 40.3 percent in 1976 to 32.8 percent in 1979.

Table 4-5 provides a profile of the capital structure of corporations by size classification. The debt coverage ratio of the medium-sized corporations appears to be in a better position than the rest of the corporations in the industry. The other data show no clear pattern in financial health related to corporate size.

4.4.2 Financial Status of Reporting Entities

The financial profile of the reporting entities is provided in this section. The analysis at this level is important because it examines the unit or corporate structure that is most closely related to the copper forming operations. As stated earlier, copper forming is carried out by many different types of companies. Some copper forming operations are segments of large vertically

TABLE 4-5. CAPITAL STRUCTURE BY SIZE OF CORPORATION INVOLVED IN COPPER FORMING*
(Percentage)

TOTAL SALES (MILLIONS OF 1979 DOLLARS)	DEBT COVERAGE RATIO	DEBT/EQUITY	LONG-TERM DEBT/TOTAL CAPITALIZATION	CAPITAL EXPENDITURES/ SALES RATIO	POLLUTION CAPITAL EXPENDITURES/ SALES RATIO	ASSETS/SALES
Very Large $10,000	802.44	35.57	25.35	4.49	0.18	43.22
Large $9,999 - $1,000	523.98	27.96	20.88	4.96	2.39	45.36
Medium-Large $999 - $100	581.16	84.07	44.00	5.19	0.20	39.56
Medium $99 - $20	1,963.34	73.42	39.80	4.11	0.12	39.84
Medium-Small $19 - $5	690.99	55.83	39.04	3.18	1.37	27.91
Small under $5	435.98	55.56	27.12	9.33	0.49	34.73
Total	786.61	59.55	34.25	4.76	0.60	38.02

*Average over the 1976-1979 period. Data are for all corporate activities, not only for the corporation's copper forming operations.

SOURCE: Compiled by JRB Associates from data provided in the 308 Economic Survey.

integrated metal products companies; some are subsidiaries of other types of large corporations (e.g., subsidiaries of oil companies). By identifying the reporting entity and analyzing this segment, a better understanding of the financial condition of the copper forming industry segment is realized.

Two important groups of profitability ratios are analyzed. The first group shows profitability in relation to the long-term investments of the copper forming reporting entities: return on gross and net assets. These ratios provide information on the earning power of the reporting entities' assets. The second group of ratios shows profitability in relation to sales--profit margins before taxes and profit margins before taxes and metal input expense (gross profit margin). Examination of these two ratios at the reporting entity level provides greater insights into the efficiency of the copper forming operations than by examining a single ratio. For example, if the gross profit margin (i.e., profit margin before taxes and the cost of metal inputs) is unchanged over a period of years, but the profit margin before taxes has declined over the same period, then this change can be attributed to the higher costs of the metal inputs. On the other hand, if the gross profit margin falls, then the cost of the metal inputs in relation to sales is declining. This type of analysis is especially important when vertically integrated plants are involved, since integrated plants can benefit or suffer depending on the price of the metal input, especially during periods of high or low demand for copper forming products.

Table 4-6 provides a summary of the average profitability ratios for 43 copper forming reporting entities over the 1976-1979 period.[11/] The data suggest that the profitability of the reporting entities has been improving, although they suffered slight profit losses in 1977. For example, the return on gross assets dropped from 19.2 percent in 1976 to 18.6 percent in 1977 but recovered to 21.8 percent in 1978, and by 1979 the return on gross

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[11/] A copper forming reporting entity may include one or more copper forming plants.

TABLE 4-6. KEY FINANCIAL RATIOS FOR THE COPPER FORMING REPORTING ENTITIES
(Percentage)

FINANCIAL RATIOS	1976	1977	1978	1979
Return on Gross Assets	19.17	18.56	21.82	23.67
Return on Net Assets	36.41	36.92	45.17	49.37
Profit Margin Before Taxes (Net)	6.01	5.19	6.06	6.11
Profit Margin Before Taxes and Cost of Metal Input (Gross)	13.01	11.95	13.06	13.60

SOURCE: Compiled by JRB from data provided in the 308 Economic Survey.

assets reached 23.7 percent. The profit margins for the reporting entities also shared a similar trend. The reporting entities experienced a small decrease in profit margins in 1977, but their profitability improved from 5.2 percent for that year to 6.1 percent in 1979. The spread between the profit margin before taxes and the profit margin after taxes plus the cost of metal inputs remains relatively constant, suggesting that the metal input price did not fluctuate significantly over the period of analysis.

Table 4-7 summarizes the data that are available on the profitability of the copper forming reporting entities by size classifications. Four-year averages are analyzed to mitigate the effects of annual variances in performance. The data indicate no reason to expect variances in financial performance because of entity size. Moreover, they indicate that there are differences in the operating characteristics among the entities that cannot be explained by the given data. These differences include such items as asset turnover rates, metal costs, depreciation schedules used, and product mix.

4.4.3 Plant-Level Assessment

Although a more comprehensive analysis at the plant level is presented in chapter 7, this section briefly reviews some important characteristics of the copper forming plants. It is estimated that there are about 176 plants in the copper forming industry, which employ approximately 43,000 people. These plants can be divided into two basic categories: "brass mills" that are involved in producing brass and bronze products (sheet, plate, rod and bar, etc.) and "wire mills" involved in producing only copper wire. A sample of 99 of these plants (see table 4-8) indicates that there are many small- to medium-sized plants in the industry. Only 7 of the 99 copper forming plants responding to the 308 Economic Survey had over 1,000 employees, whereas 78 of the plants had less than 500 employees. The average annual production of the plants was approximately 60 million pounds of copper.

TABLE 4-7. PROFITABILITY ASSESSMENT BY SIZE OF THE REPORTING ENTITY, 1976-1979*
(Percent)

TOTAL 1979 SALES** ($ Millions)	RETURN ON GROSS ASSETS	RETURN ON NET ASSETS	PROFIT MARGIN BEFORE TAXES	PROFIT MARGIN BEFORE TAXES AND METAL INPUT
Very Large $2,000 - $500	22.29	43.05	6.40	8.68
Large $499 - $100	15.68	31.53	4.32	10.73
Medium $99 - $25	25.38	44.40	7.00	16.55
Medium-Small $24 - $5	21.35	47.99	7.05	12.24
Small under $5	22.23	45.90	4.85	10.72
All Entities	20.79	41.88	5.85	12.96

*Average financial ratios for the 1976-1979 period.

**Not all of these sales are due to copper forming. 1979 dollars.

SOURCE: Compiled by JRB from data provided in the 308 Economic Survey.

TABLE 4-8. SIZE DISTRIBUTION OF SAMPLE OF COPPER FORMING PLANTS, 1979

NUMBER OF EMPLOYEES	NUMBER OF PLANTS	AVERAGE PRODUCTION (000 lbs)*
1 - 24	6	2,303
25 - 49	4	7,868
50 - 99	13	14,888
100 - 199	25	23,085
200 - 299	15	30,563
300 - 399	8	60,849
400 - 499	7	151,994
500 - 999	14	153,791
> 1,000	7	164,404
TOTAL IN SAMPLE	99**	60,406

*Average per plant production for employment-size classification.

**176 plants in total but only 99 of the copper forming plants responding to the Section 308 Economic Survey provided enough data to be included in this table. Four additional copper forming plants which responded to the 308 Economic Survey did not provide the data needed for this table.

SOURCE: Compiled by JRB Associates from data provided in the 308 Economic Survey.

4.5 CONCLUSIONS

The analysis of the copper forming industry structure and performance reveals that the industry is relatively competitive. Although a large segment of the market is vertically integrated, the structure of the industry is such that individual firms are not in a position to control or influence market forces or prices in a perceptible manner. Market concentration is moderate and entrance into the industry is relatively easy. The empirical data on the industry's performance confirm this finding. The financial data reveal that the industry as a whole is earning profits below that of comparable industries, although not alarmingly low. Moreover, the industry appears to be in a position to finance moderate levels of additional debt. The results also suggest that economies of scale are not an important factor in this industry.

5. BASELINE PROJECTIONS OF INDUSTRY CONDITIONS

This section provides projections of economic conditions that are likely to exist in the copper forming industry markets through 1990. The baseline projections assume compliance with all existing environmental regulations. These baseline projections assume that no new water pollution control requirements mandated by the Clean Water Act, including the recommended effluent guidelines, are imposed on the copper forming industry during this period. The demand and supply projections and parameter estimates of the equations developed in this section will be used together with other information, including estimated compliance costs, to assess the effects of the effluent control requirements on future industry conditions.

The baseline projections in this report provide a general point of reference from which the relative and absolute magnitudes of the impacts from EPA's copper forming regulation can be measured. These projections provide a plausible picture of future developments and are to be used as a benchmark for comparison, and not as a comprehensive, authoritative forecast of future industry conditions. However, even though minor changes to the baseline projections may result from more recent data and sophisticated forecasting techniques, they are not likely to significantly alter the overall conclusions.

Our basic approach began with the development of explicit demand and supply functions that explain the behavior of the copper forming market over the 1960-1979 historical period. The forecasts of future levels of demand and supply for the major product groups are then calculated based on the established historical relationships and on projections of the explanatory variables in the demand and supply functions. Supply factors were also assessed to determine if there would be any significant changes in the level of capital requirements or growth in the number of plants over the regulatory impact period.

5.1 DEMAND-RELATED FACTORS

The demand for copper forming products refers to the quantity buyers are willing to purchase at different prices, everything else being equal. However, an analysis of demand requires a distinction between the uses and the demand for copper forming products. These variables are not definitionally identical. Uses of copper refer to the disposition of copper on hand (e.g., copper is used in the transportation, building, and communication industries). On the other hand, demand for copper forming products refers to specific types of copper products (e.g., copper sheets, plates, tubes). Moreover, since data on copper forming product flows are usually collected in terms of production, consumption by end-use, inventories, imports, and exports, it is necessary to determine the annual demand for copper forming products. The copper forming products' demand is estimated by adding imports to, and subtracting exports and changes in inventories from, the annual production figures. Using this approach, the quantity demanded is estimated (i.e., point estimates of demand over time) for four copper forming product categories: sheet, strip, and plate; rod, bar, and mechanical wire; tube and pipe; and wire mill products.

5.1.1 Theoretical Considerations

There are a number of factors that must be considered when analyzing the demand for copper forming products. First, the demand for copper forming products is inversely related to its price [i.e., as the relative price rises (falls), the demand for copper products decreases (increases)]. Second, the demand for copper is a derived demand which arises from the final demand for the goods for which it is an input. Consequently, there is a direct relationship between the general utilization of copper forming products and the industrial production of durable manufactured goods. As industrial production of durable manufactured goods increases, the demand for copper forming products increases. For greater specificity, the demand for each of the copper forming products can be analyzed by relating it to its specific end-use. The demand for wire mill products, for example, can be associated with the demand for communication and building materials. Finally, the demand for copper is directly related to the price of substitute goods. In the manufacturing process of various end-users of copper forming products, there exist other materials that could be used instead of copper, even though they are not "perfect" substitutes. The most important substitutes for copper include aluminum, stainless steel, fiber optics, and plastics. Each substitute is a competitor to copper in limited situations. For example, aluminum is a substitute for copper mainly in wire products, and plastics are more important substitutes in the case of consumer products. Each of these factors are considered in the estimation of explicit demand functions for the copper forming industry segments.

5.1.2 Econometric Analysis and Considerations

Econometric analysis is a statistical technique which is used within an economic framework to analyze the relationship of key explanatory variables to the movement of select variables under study. It is an empirical approach that is extensively used in economic and business analysis to quantify relationships among variables and to predict market phenomena. In demand analysis it is used to quantify and empirically test the influence of the product's price, the prices of substitutes and complements, and general income levels (i.e., economic activity) on the demand for a product. Once a relationship is made explicit, a forecast of future demand conditions can be based on predictions of the explanatory variables and the estimated behavioral coefficients.

5.1.2.1 Long-Run Dynamic Adjustment Process

In this analysis the demand for copper forming products is specified as a function of its relative price and the level of economic activity related to the specific copper forming product. However, since the purchasers of copper forming products do not generally change their consumption patterns in response to short-term movements in the price or changes in price within a given time period, a dynamic model specification is used to capture this long-run adjustment process.

In general, purchasers of copper forming products would not change their consumption of copper, due to short-run movements in the price or activity variables, because of technological and institutional constraints. This is so because, even though aluminum, steel, wood, and plastics are some of the materials that can be substituted for copper products in some applications, it is often not possible to make a direct substitution of one material for another in an ongoing manufacturing process as the price of copper increases. Substitution generally requires new types of manufacturing equipment or major modifications to existing equipment, and the substitute material must offer rather decisive advantages in cost and performance over the long term to justify the cost of adopting a new manufacturing process or designing and constructing a new manufacturing plant to use it. As a result, the substitution of one material for another usually takes place over a relatively long period of time, and then only under overwhelming conditions such as when:

- The substitute material maintains desirable properties at low costs
- The substitute is perceived to be available in sufficient quantities
- The substitute is adaptable to commercial manufacturing processes.

In most cases, major consumption decisions are made on the basis of changes that occur over an extended period of time and not changes in a single point in time. In the short run, consumers of copper forming products may not be able to switch to substitutes because of higher prices. If prices are expected to remain high in the long run, consumers may switch to aluminum. Hence, short- and long-run elasticities of demand may be different. Also, in the copper forming industry, less copper per dollar of output may be used in the long run as compared to the short run; i.e., there is induced technological change as the price of raw copper rises (or falls).

To explain this type of demand behavior in the copper forming industry, a distributed lag equation structure (Koyck model specification) is used to capture the long-run adjustment process that is observed as prices and the industrial activity variables (income) change over time. An example of a demand function of the Koyck type (i.e., assuming that the lag weights decline geometrically) is given in equation (5.1) below.

$$(5.1) \qquad c_t = a_o + a_1 \sum_{i=0}^{n} \lambda^i y_{t-1} + a_2 \sum_{i=0}^{n} \lambda^i p_{t-1}$$

where:

c_t = consumption of copper forming products in period t

y_t = industrial activity or income in period t

p_t = price of copper in period t

and where λ is defined as the reaction coefficient and takes on values from $0 \leq \lambda \leq 1$. Estimated values of λ are normally obtained through the use of a transformed equation. This requires multiplying the above equation lagged one period by λ,

$$(5.2) \qquad \lambda c_{t-1} = \lambda a_o + a \sum_{i=1}^{n} \lambda^i y_{t-1} + a_2 \sum_{i=1}^{n} \lambda^i p_{t-1}$$

and subtracting it from the original equation to obtain

$$(5.3) \qquad c_t = a_o(1-\lambda) + a_1 y_t + a_2 P_t + \lambda c_{t-1}$$

Equation (5.3) can be stated in a set of composite coefficients and a stochastic disturbance term that would result from estimation.

$$(5.4) \qquad c_t = b_o + b_1 P_t + b_2 y_t + b_3 c_{t-1} + u_t$$

Since the parameters λ, a_o, a_1, and a_2 can be determined uniquely from b_o, b_1, b_2, and b_3, equation (5.3) is approximately identified and can be estimated using the ordinary least squares regression method. The estimated parameters would correspond as follows:

$$\lambda = b_3 \quad a_1 = b_1$$

$$a_o = b_o/(1-\lambda) \quad a_2 = b_2$$

A useful property of the Koyck lag function is that it permits a distinction to be drawn between short-run and long-run adjustments or elasticities. The estimates of b_1 and b_2 represent the short-run income and price coefficients and the values of $b_1/(1-\lambda)$ and $b_2/(1-\lambda)$ represent the respective long-run elasticities.[1] A priori, the short-run adjustment (elasticity) must be less than the long-run elasticity, since in the long run consumers have time to switch over to substitutes.

5.1.2.2 Data Availability

The specification of the preceding model was developed and estimated using annual time series data over the 1960-1979 period. The historical consumption data were derived from information provided by the Copper Development Association. Since actual consumption figures are not available, an estimate of the apparent consumption for each year is calculated by subtracting exports and inventory changes from, and adding imports to, production. The price of copper wire bar is used as a proxy for the price of copper forming products. This is appropriate since this price is used as the basis for changes in the copper forming industry price. Generally, the price of copper forming products is determined by adding a fixed processing fee (toll) to the price of wire bar. The annual average price quotations for wire bar products were obtained from the American Metal Market, 1979 Metal Statistics. The price series was transformed into constant dollars or relative prices by dividing the current price series by the copper mill price index. Since the demand for copper forming products is highly related to changes in the total fabrication metal industry, the Federal Reserve Board production index for fabricated metal products was used as the activity variable.

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[1] Walter C. Labys, Dynamic Commodity Models: Specification, Estimation, and Simulation (Chicago: Lexington Books, 1973).

5.1.3 Empirical Results

The ordinary least squares technique was used to estimate the demand functions (equation 5.4) for each of the copper forming products. The results of the analysis for each of the product groups, including the total brass mill product group, are shown in table 5-1. The signs of all the coefficients meet with a priori expectations (i.e., the signs of price coefficients are all negative and the signs of the income coefficients are all positive for each of the product groups). The coefficients are significant at the 90 percentile level for all segments, except those of the plumbing tube and pipe subcategory. The relatively high R^2s indicate that the explanatory variables are explaining most of the movement in the dependent variables.

In addition to these statistical criteria, the price elasticities from each of the structural equations were calculated and evaluated. The price elasticities of demand (calculated at the means) for each product group are shown in table 5-2. In each case the implied long-run elasticity is greater than the short-run elasticity. Moreover, the short-run elasticity estimates are consistent with other elasticity estimates calculated for the entire copper industry.[2] The short-run elasticity estimate ranges from a high of -1.3 (fairly elastic) for the sheet, strip, and plate product group to -0.4 (inelastic) for the tube and pipe product group.

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[2] Estimates of elasticities are provided in the following publications: Charles River Associates, Policy Implications of Producer Country Supply Restrictions: The World Copper Market (Cambridge, Massachusetts: August 1976); and F. N. Fisher, P. H. Coutneau, and M. N. Baily, "An Econometric Model of the World Copper Industry," Bell Journal of Economics and Management Science, Vol. 2 (Autumn 1972), pp. 568-664.

TABLE 5-1. EMPIRICAL RESULTS OF ANALYSIS OF DEMAND FOR COPPER FORMING PRODUCTS*

COPPER FORMING DEMAND PRODUCT GROUPS	CONSTANT	LAG DEPENDENT VARIABLE	PRICE VARIABLE	ECONOMIC ACTIVITY VARIABLE	R^2	D.W.	SER
Sheet, Strip, and Plate	1,742.8 (3.3)	0.06542 (0.34)	-3,471.13 (-2.8)	6.61 (4.0)	0.7	1.2	108.9
Plumbing Tube and Pipe	686.54 (1.2)	0.579 (3.02)	-811.43 (-0.7)	0.27 (0.2)	0.4	1.5	111.5
Rod, Bar, and Mechanical Wire	1,298.6 (2.5)	-0.0393 (-0.18)	-2,100.59 (-1.7)	4.842 (3.6)	0.6	1.4	108.7
Total Brass Mill Products	3,710.1 (2.3)	0.229 (1.1)	-6,181.1 (-1.7)	10.12 (2.5)	0.5	1.3	321.8
Wire Mill Products	1,294.38 (1.5)	0.289 (1.5)	-2,791.3 (-1.3)	14.49 (3.7)	0.9	1.1	187.1

*The "t" statistics are in parentheses.

SOURCE: Compiled by JRB Associates based on the demand and supply model of the copper forming industry that was developed for this study.

TABLE 5-2. PRICE ELASTICITY ESTIMATES FOR THE DEMAND FOR COPPER FORMING PRODUCTS*

DEMAND PRODUCT GROUPS	SHORT-RUN PRICE ELASTICITY	LONG-RUN PRICE ELASTICITY
Sheet, Strip, and Plate	-1.3	-1.4
Plumbing Tube and Pipe	-0.4	-0.9
Rod, Bar, and Mechanical Wire	-0.9	-1.0
Wire Mill Products	-0.5	-0.7

*Elasticity estimates are calculated at the means.

SOURCE: Compiled by JRB Associates based on the demand and supply model of the copper forming industry that was developed for this study.

5.1.4 Demand Forecasts

The demand forecasts were generated by fitting the estimated coefficients with predictions of future values for the explanatory variables. In the baseline projections it is assumed that the industry prices will increase in relation to the level of inflation in the economy over the forecast period. Since relative prices and not current prices are considered in a demand function, the real price of copper is not expected to change over the forecast period. The forecast of the Federal Reserve Board (FRB) fabricated metal index is based on the growth rate of the fabricated metal products index provided by Predicast.

Table 5-3 provides the results of the forecasting exercise for each of the product groups. Overall, the results indicate that the demand for copper forming products is not likely to increase uniformly over the 1982-1990 period. Increases (in relative terms) are predicted to be the greatest for the sheet, plate, and strip product group which is expected to expand to 1.7 billion pounds or by 86 percent over its 1982 level. The smallest increase in demand is projected for the plumbing tube and pipe subcategory which is expected to increase to 928 million pounds by 1990. The quantity of products demanded for the rod, bar, and mechanical wire is expected to increase to 1,320 million pounds or approximately 74 percent. Finally, wire mill products are expected to increase by 78 percent over the 1982-1990 period.

5.2 SUPPLY FACTORS

In this section baseline projections for future levels of supply are provided for each of the four groups. In addition to the projected production levels, estimates are provided for capital expenditures in plant and equipment and the growth in new plants necessary to satisfy the projected production levels. These baseline estimates assume that no additional resources are expended to meet effluent pollution control requirements that may result from the Clean Water Act.

TABLE 5-3. COPPER FORMING PRODUCTS DEMAND FORECASTS*

YEAR	PRODUCT GROUPS (Millions of Pounds)			
	SHEET, STRIP, AND PLATE	PLUMBING TUBE AND PIPE	ROD, BAR, AND MECHANICAL WIRE	WIRE MILL PRODUCTS
1980	985.4	720.0	917.2	2,690.4
1981	1,148.7	786.6	1,063.9	2,760.5
1982	909.3	673.0	759.1	2,350.8
1983	1,392.0	871.4	1,125.3	3,296.9
1984	1,459.2	888.4	1,169.6	3,490.1
1985	1,526.4	900.8	1,213.9	3,490.1
1986	1,561.2	909.3	1,234.4	3,806.0
1987	1,593.9	915.4	1,255.9	3,908.0
1988	1,626.5	920.1	1,277.3	4,004.1
1989	1,659.0	924.1	1,298.7	4,098.4
1990	1,691.5	927.6	1,320.2	4,192.3

*1980, 1981, and 1982 are actual figures. Forecasts are given for the 1983-1990 period.

SOURCE: Compiled by JRB Associates based on a forecast from the demand and supply model of the copper forming industry that was developed for this study.

5.2.1 Theoretical and Empirical Considerations

5.2.1.1 Long-Run Dynamic Adjustment Process

The supply of copper forming products refers to the quantity of products producers are willing to produce (supply to the market) at a given price, assuming other factors remain constant. A priori, the supply of copper forming products is positively related to the relative price of copper [i.e., as relative prices increase (decrease), the supply of copper forming products increases (decreases)].

Prices, however, are not the only variable that influences the supply of copper forming products. The ability to expand output in this industry also depends on variable costs and/or the ability to utilize the current stock of machinery and labor more intensively. For example, it is doubtful whether a plant could expand its production significantly if wages or other production costs per unit of output increase precipitously as output expands or if the machinery is being used at its full capacity. Therefore, information on the level of capacity utilization of the copper forming industry would provide some indication of this industry's ability to expand its productive forces (i.e., labor and capital) and output over time. At low levels of capacity. utilization, current production would be low and expansion of output possible. On the other hand, at high levels of capacity utilization, the industry productive capacity would be constrained by labor and capital shortages and would be producing close to its limit, at which point the industry would be unable to significantly increase its output in the short run. Increased output can be forthcoming only in the long run as new plants and machinery come on stream, new workers are trained, and existing plants are expanded.

Furthermore, the supply response to price changes is not immediate in most cases, but is spread over a long period. It takes time to build up new productive capacity (i.e., to train new workers and construct new plants). To capture this long-run response, the supply function uses the Koyck lag structure, as previously explained. The supply curves are expressed in the form:

$$S_t = \alpha_0 + \alpha_1 P_t + \alpha_2 CU_t + \alpha_3 S_{t-1} + e_t \qquad (5.5)$$

where

S = supply of copper forming products
P = price of copper forming products
CU = level of capacity utilization in the copper forming industry
t = annual time period

and α_0, α_1, α_2, and α_3 are the estimated coefficients of the explanatory variables, and e_t is the stochastic error, respectively. The distributive lag form of this model (i.e., the Koyck model specification) is derived similarly to the demand model above. It assumes that the supply response is dependent on price and industry capacity changes spread over a long period of time.

5.2.1.2 Data Availability

Annual time series data over the 1960-1979 period are used for each of the product groups. The annual production data for each of the four product groups are obtained from the Copper Development Association's Annual Data Reports. The price information is from the American Metal Market, 1979 Metal Statistics. For brass mill products the price of copper scrap is used as a proxy for the price of the brass products. Copper scrap prices are a good proxy for the brass mill product sectors for the following reasons:

- A significant amount of scrap is consumed by this product group.[3]
- Prior to 1978 producer list prices were relatively stable, while scrap prices varied according to market forces.

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[3] A typical brass mill does not smelt or refine scrap. Instead, primary scrap is melted and reformed.

One possible reason for relatively stable prices in the domestic market may be because producers tend to provide discounts (which are not observable) to their customers while maintaining their list prices on the books. Scrap prices, however, are competitive and do reflect changes in the market. On the other hand, wire mills do not consume any scrap, therefore, the use of this variable would be inappropriate for explaining copper wire supply. In the wire mill product group equation the price of copper wire is used.

The data on capacity utilization for the copper forming industry are from the Federal Reserve Board. The time series data from this source has missing observations for years prior to 1966 (and had to be estimated). Since the level of capacity utilization is highly related to the level of demand in the copper forming industry, the 1960-1966 capacity utilization levels are estimated from established relationships between these two variables over the period for which data are available. Using the capacity utilization/demand relationship and data on the industry demand over 1960-1966, estimates of the missing observations are generated.

5.2.2 Empirical Results

The results of the empirical analysis for the supply of copper forming products are provided in table 5-4. Overall, these results are reasonable. All the price variable coefficients, except for the wire mill category, are statistically significant at the 95 percentile level. Both the signs and magnitudes of the price coefficients are consistent with our *a priori* expectations. The signs on all the price coefficients are positive, and the responsiveness of supply in the short and long run are consistent, i.e., the long-run coefficients are greater than the short-run coefficients (see table 5-5). The short-run elasticity estimates (calculated at the means) range from a low of 0.1 for the wire mill product group to a high of 0.4 for the rod, bar, and mechanical product group. The supply price elasticities are slightly more responsive in the long run.

TABLE 5-4. EMPIRICAL RESULTS OF ANALYSIS OF SUPPLY FOR COPPER FORMING PRODUCTS*

COPPER FORMING SUPPLY PRODUCT GROUPS	CONSTANT	LAG DEPENDENT VARIABLE	PRICE VARIABLE	CAPACITY UTILIZATION RATE	R^2	D.W.	SER
Sheet, Strip, and Plate	-183.9 (-1.4)	0.190 (1.6)	858.5 (3.0)	9.28 (5.5)	0.8	2.3	73.5
Plumbing Tube and Pipe	42.8 (0.3)	0.078 (0.4)	1,094.5 (2.9)	5.04 (3.1)	0.7	1.1	74.2
Rod, Bar, and Mechanical Wire	-55.3 (-0.6)	-0.75 (-0.8)	402.2 (2.0)	11.46 (9.9)	0.9	2.2	50.8
Total Brass Mill Products	-92.3 (-0.4)	-0.05 (-0.6)	2,534.7 (5.0)	27.8 (9.8)	0.9	2.5	123.3
Wire Mill Products	-745.97 (-3.3)	0.432 (4.9)	342.6 (0.6)	24.6 (7.5)	0.9	1.4	114.0

*The "t" statistics are in parentheses.

SOURCE: Compiled by JRB Associates based on the demand and supply model of the copper forming industry that was developed f study.

TABLE 5-5. SUPPLY PRICE ELASTICITY ESTIMATES FOR THE COPPER FORMING INDUSTRY*

SUPPLY PRODUCT GROUPS	SHORT-RUN ELASTICITY	LONG-RUN ELASTICITY
Sheet, Strip, and Plate	0.3	0.3
Plumbing Tube and Pipe	0.4	0.4
Rod, Bar, and Mechanical Wire	0.1	0.2
Total Brass Mill Products	0.3	0.3
Wire Mill Products	0.1	0.2

*Elasticity estimates are calculated at the means.

SOURCE: Compiled by JRB Associates based on the demand and supply model of the copper forming industry that was developed for this study.

5.2.3 Supply Forecasts

Predictions of the explanatory variables are fitted to the estimated coefficients to generate forecasts for each of the product groups over the 1983-1990 period. Since it is assumed that prices will increase at the same rate as inflation, real prices are assumed to remain constant over the forecast period. The forecast of capacity utilization for the copper forming industry is based on future levels of copper consumption in the economy. The relationship that is established to provide estimates of the missing data for the capacity utilization levels (i.e., over the 1960-1966 period) is used to predict values for the copper forming capacity utilization rates over the 1980-1990 period.

Using the supply functions developed above, forecasts of production levels for each of the product groups are generated based on the estimated coefficients and forecasts of the explanatory variables in each product group. Table 5-6 shows the results of the baseline supply forecasts for the copper forming industry. Overall, the rate of growth in the future supply of copper forming products is less than the rate of growth in the demand forecasts. The sheet, strip, and plate product group is forecast to increase by about 81 percent over its 1982 level of production by 1990. The supply of rod, bar, and mechanical wire products is expected to increase by 82 percent over the 1982-1990 period. The tube and pipe product group is expected to increase by 60 percent above its 1982 level. The supply forecast for wire mill products is expected to be about 57 percent over its 1982 production level.

5.3 ANTICIPATED GROWTH AMONG TYPES OF PLANTS

Growth in industry can come about in at least four different ways:

- By expanding the current capacity utilization of the plant (i.e., assuming that there is some excess capacity or the plant is not working at 100 percent of its capabilities, a plant can produce more by working its machinery and labor more intensively);

TABLE 5-6. COPPER FORMING PRODUCTS SUPPLY FORECASTS*

	PRODUCT GROUPS (Millions of Pounds)			
YEAR	SHEET, STRIP, AND PLATE	PLUMBING TUBE AND PIPE	ROD, BAR, AND MECHANICAL WIRE	WIRE MILL PRODUCTS
1980	873.0	764.0	895.0	2,798.0
1981	969.0	752.0	899.0	2,872.0
1982	736.0	616.0	680.0	2,425.0
1983	1,154.5	901.1	1,073.8	3,102.2
1984	1,195.5	920.4	1,111.2	3,243.2
1985	1,235.9	939.6	1,148.7	3,390.6
1986	1,259.4	949.7	1,165.4	3,496.1
1987	1,279.7	959.1	1,183.7	3,583.6
1988	1,299.3	968.4	1,201.8	3,663.2
1989	1,318.9	977.7	1,220.0	3,739.5
1990	1,338.4	987.0	1,238.1	3,814.3

*1980-1982 are actual figures. Forecasts are given for 1983-1990.

SOURCE: Forecasts of the copper forming model that was developed by JRB Associates.

- By addition of new facilities, equipment, and technology to the existing plant. Given the space and the existence of scale economies, a plant may expand its output by replacing old machinery with new or adding to existing machinery;

- By construction of new plants in order to expand; or

- By new firms entering the industry, assuming the rate of return is much higher than the market rate of interest and the risk associated with copper forming.

In recent years the copper forming industry has been operating below its production capacity. This has been especially true during periods of recession when the producers' price deviates widely from the prices quoted on the commodity markets. During periods of recession, producers in the copper forming industry reduce their production significantly or carry large inventories. Additionally, in periods when the domestic producers' price is higher than the commodity market quotations, purchasers buy copper forming products from abroad; consequently, producers are forced to cut back production levels or increase inventories. Furthermore, the profitability of the copper forming companies is not significantly above that of companies with comparable risk. These factors tend to keep the copper forming industry output below its potential capacity levels in most years and to discourage new entries into this segment of the industry.

The copper forming industry is also a very mature industry that has not grown rapidly during the last decade. Generally, most of the new capacity has come from existing plants and from new plants built overseas where low cost inputs are available. This trend appears likely to continue when the high costs of labor, copper, and environmental and other regulations for new sites are considered. As a result, any significant new productive capacity over the next decade is likely to come predominantly from investment in improvements to machines in place, introduction of new machines, and the construction of new plants abroad.

Information from the most recent annual reports (1982) of companies with copper forming plants indicates that four new plants will be built, plus two plants will have major expansions:

- Chase Brass and Copper plans to complete a new commercial plant to produce narrow strip copper products by mid-1983.
- Handy Harmon recently constructed a fully automated facility in La Grange, Georgia.
- Phelps Dodge Industries, Inc. built a new plant in Norwich, Connecticut, in 1981 that has a 180,000-ton capacity.
- Phelps Dodge Industries, Inc. also completed a new mill in El Paso, Texas, within its $25 million budget during the third quarter of 1982.
- Chase Brass and Copper Co. expanded its rod plant in William County, Ohio, by 50 percent during 1982.
- ARCO Metals Company plans to spend $11 million on its brass mill in Buffalo, New York, early in 1984. According to ARCO's 1982 annual report, this expansion will result in lower unit production costs and will increase capacity by 40 percent to 31 million pounds of metal each month, making this facility the nation's largest brass mill.

Our forecast of new plants is restricted to the four new plants and the two major plant expansions that have been identified, since there is no other information to suggest that other new plants will be built over the next ten years.

6. COST OF COMPLIANCE

6.1 INTRODUCTION

The water treatment control systems, costs, and effluent limitations and pretreatment standards recommended for the copper forming industry are enumerated in the Development Document for Effluent Limitation Guidelines and Standards of Performance for the Copper Forming Point Source Category (Development Document. This document identifies various characteristics of the industry including manufacturing processes, products manufactured, volume of output, raw waste characteristics, sources of waste and wastewaters, and the constituents of wastewaters. This information serves as the basis for reflecting the effluent limitations and pretreatment standards and estimating the costs of the treatment control systems.

The EPA Development Document identifies and assesses the range of control and treatment technologies that apply to copper forming wastes. This assessment involved an evaluation of both in-plant and end-of-pipe pollution control technologies that could be designed for this industry. This information is then evaluated for existing direct industrial dischargers to determine the effluent limitations achievable based on the "best practicable control technology currently available" (BPT) and the "best available technology economically achievable" (BAT). Similar evaluations were performed for new direct dischargers to develop new source performance standards (NSPS). Finally, pretreatment standards for existing sources (PSES) and pretreatment standards for new sources (PSNS) are developed for dischargers to publicly owned treatment works (POTWs). Each of the technologies identified is analyzed to calculate cost and performance. Cost data are expressed in terms of investment, operating and maintenance, and total annual costs.

A further discussion of the cost methodology is provided in Section VIII of EPA's Development Document.

6.2 CONTROL TREATMENT OPTIONS

EPA considered the following treatment and control options as the basis for BPT, BAT, NSPS, PSES, and PSNS for facilities within the copper forming industry.

- Option 1: Option 1 is end-of-pipe treatment, consisting of lime precipitation and settling, and preliminary treatment, where necessary, consisting of chemical emulsion breaking, oil skimming, and chromium reduction. For forged parts, this option also consists of spray rinsing and recirculation for pickling rinse and flow normalization for alkaline cleaning rinse. This combination of technology reduces toxic metals, conventional pollutants, and also toxic organics through oil skimming.

- Option 2: Option 2 is equal to Option 1 plus flow reduction for three waste streams: annealing water, solution heat treatment, and pickling rinse. Flow reduction of the annealing water and solution heat treatment streams is based on recycle, and flow reduction of the pickling rinse stream is based on spray rinsing and recirculation. The Option 1 flows for these streams are reduced and this reduction will decrease toxic metals and conventional pollutants.

- Option 3: Option 3 is equal to Option 2 plus filtration for further reduction of toxic metals and TSS.

- Option 4: Option 4 consists of lime precipitation, settling, and filtration, where necessary, preliminary treatment consisting of chemical emulsion breaking, oil skimming, and chromium reduction, with countercurrent rinsing and other methods of flow reduction.

- Option 5: Option 5 is equal to Option 1 plus filtration for reduction of toxic metals and TTS.

For existing sources, Options 4 and 5 were rejected for technical reasons and their costs are not reported here. Option 4 is demonstrated at only a few copper forming plants; most existing plants lack the space required by countercurrent rinsing. Option 5, compared to Option 2, removes only one-fourth the pollutants at approximately the same costs. (Option 4, however, as a recommended technology for new sources, is costed.)

The pollutants selected for regulation are: chromium, copper, lead, nickel, zinc, oil and grease, TSS, pH, and TTO. These are the same pollutants that were selected for regulation in the proposed rule.

Each of these recommended control options is expected to generate more solid wastes than are generated by the current treatment systems in use in copper forming plants. The costs of the control options include estimates for the cost of hauling and disposing of these additional solid wastes. The cost estimates reflect EPA's view that the solid wastes generated by the proposed control options are not expected to be classified as hazardous under the regulations of the Resource Conservation and Recovery Act (RCRA).

6.3 ESTIMATED COMPLIANCE COSTS

6.3.1 Existing Sources

The number of plants in the copper forming industry is estimated at 176. Of this total, 37 plants are considered direct dischargers and 45 plants indirect dischargers (i.e., they discharge their wastewater to POTWs). The remaining 94 plants do not discharge any wastewater and therefore would not incur treatment costs.

Actual compliance costs for Options 1, 2, and 3 were estimated for 14 direct and 17 indirect dischargers.[1] The costs from these plants are used to project the compliance costs for the total industry. This is accomplished by determining the average costs that are required to comply with each of the BAT and PSES regulatory options and then multiplying the results by the total number of direct and indirect dischargers in the industry.

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[1] The compliance costs used in the economic analysis are those provided by the Effluent Guidelines Division on July 31, 1983. Of the 31 plants for which cost data are estimated, only 18 of these plants provided adequate financial data.

Tables 6-1 and 6-2 provide the estimated total industry costs in 1982 dollars for the first three pollution control options considered for BAT and PSES. The total industry investment costs for direct dischargers are approximately $5.8 million, $6.5 million, $7.9 million, and the annual costs, which include the operating and maintenance costs plus depreciation and interest, are $6.1 million, $6.3 million, and $7.4 million for Options 1, 2, and 3, respectively.[2] For indirect dischargers the total industry investment costs are $8.8 million, $9.2 million, $10.4 million, with annual costs of $7.6 million, 7.1 million, and $8.3 million, respectively.

Option 2 often costs less than Option 1, because the reduced flow Option of 2 requires smaller and less expensive end-of-pipe treatment systems. Therefore, many plants, when required to meet Option 1 limitations, will install Option 2 technology. For discussion of these costs see the Development Document (Section VIII).

6.3.2 New Sources

In order to estimate pollutant removals and costs for new sources, the Agency developed a normal plant. A normal plant is a theoretical plant that has each of the manufacturing operations covered by this regulation and production that is at the average level of the industry as a whole. Section VIII of the Development Document presents in detail the composition of the copper forming normal plant.

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[2] Annual costs are calculated using a capital recovery factor of 0.22. For a discussion of this capital recovery factor, see Economic Impact Analysis of Proposed Effluent Limitations and Standards for the Organic Chemicals, Plastics and Synthetic Fibers Industry, EPA, March 1983, Appendix 2A.

TABLE 6-1. COMPLIANCE COSTS FOR COPPER FORMING INDUSTRY DIRECT DISCHARGERS*
($ Millions)

POLLUTION CONTROL TECHNOLOGY	NUMBER OF PLANTS INCURRING COSTS	TOTAL COSTS ENTIRE INDUSTRY		
		INVESTMENT	O&M	ANNUAL
Option 1	37**	$ 5.8	$ 4.8	$ 6.1
Option 2	37	$ 6.5	$ 4.9	$ 6.3
Option 3	37	$ 7.9	$ 5.6	$ 7.4

*Costs are in 1982 dollars.

**11 of the 37 are expected to meet Option 1 limitations but these 11 share in the total costs.

SOURCE: Compiled by JRB Associates from data provided by EPA, Effluent Guidelines Division, July 31, 1983.

TABLE 6-2. COMPLIANCE COSTS FOR COPPER FORMING INDUSTRY INDIRECT DISCHARGERS*
($ Millions)

POLLUTION CONTROL TECHNOLOGY	NUMBER OF PLANTS INCURRING COSTS	TOTAL COSTS ENTIRE INDUSTRY		
		INVESTMENT	O&M	ANNUAL
Option 1	45	$ 8.8	$ 5.7	$ 7.6
Option 2	45	$ 9.2	$ 5.6	$ 7.7
Option 3	45	$10.4	$ 6.0	$ 8.3

*Costs are in 1982 dollars.

SOURCE: Compiled by JRB Associates from data provided by EPA, Effluent Guidelines Division, July 31, 1983.

The regulation promulgated for new sources is the same for new direct and new indirect dischargers. Both the NSPS and PSNS technologies are based on end-of-pipe treatment and in-process controls (Option 4). Table 6-3 summarizes the compliance costs associated with new sources. The total capital investment cost for a new normal plant to install NSPS or PSNS technology is estimated at $1.23 million, compared with investment costs of $1.18 million to install technology equivalent to BAT and PSES costs (Option 2). The total annual cost for a new plant to install NSPS or PSNS technology is $1.05 million, and $1.02 million for BAT.3/

3/ The results of a cost-effective analysis of the recommended pollution control technologies for existing and new sources are presented in a separate document entitled Cost-Effectiveness Anlaysis of Effluent Standards and Limitations for the Copper Forming Industry, JRB Associates, July 29, 1983.

TABLE 6-3. COMPLIANCE COSTS FOR NEW SOURCES*
($ Millions)

POLLUTION CONTROL TECHNOLOGY	COST PER NEW SOURCE		
	INVESTMENT	O&M	ANNUAL
Option 2 (BAT = PSES)	$ 1.18	$ 0.76	$ 1.02
Option 4 (NSPS = PSNS)	$ 1.23	$ 0.78	$ 1.05

*Costs are in 1982 dollars.

SOURCE: EPA, Effluent Guidelines Division.

7. ECONOMIC IMPACTS

7.1 INTRODUCTION

This chapter describes the economic impacts likely to occur as a result of the costs of alternative pollution control regulatory options on the copper forming industry. The results focus on:

- Price and Output Impacts: An analysis of the impact of the pollution abatement costs on price and output in the U.S. domestic market;
- New Capital Financing Impacts: An analysis of the ability of plants in the copper forming industry to invest in new capacity and pollution control equipment out of current and future income;
- Plant Closures: An analysis of (a) baseline plant closures (i.e., plant closures that may result even without the costs of the regulation), (b) plant closures as a result of the regulation, and (c) impact of the regulation on new plants;
- Employment Effects: An analysis of the number of layoffs that may result due to the estimated plant closures and the reduction in the output levels;
- Commmunity Impacts: An analysis of indirect effects on employment and earnings outside the copper forming industry as a result of layoffs in the copper forming industry within specific geographic areas;
- Balance-of-Trade Impacts: An analysis of the effects of price increases on the international competitiveness of domestic copper formers;
- Small Entity Impacts: An analysis of the impacts of the recommended pollution control options on small copper forming plants.

The impact assessment procedure uses the estimated investment and annual operating and maintenance costs for each option as the basis for the potential impacts. If these costs are small for individual plants in the industry, there are likely to be no significant impacts. On the other hand, if the costs are large, the industry and related plants may face serious problems if the recommended pollution control systems are required.

7.2 PRICE AND PRODUCTION IMPACTS

Tables 7-1 and 7-2 summarize the estimated price changes for each of the major product groups of the copper forming industry. Table 7-1 is derived from equation 2.1 (see chapter 2) which estimates the price increase as total annual production cost changes, and table 7-2 expresses the price increase in cents per pound of copper formed product under the assumption of a competitive market structure. The analysis presented here uses the long-run price elasticities for the specific copper forming product groups presented in table 5-2. This is necessary because short-run adjustments in the copper forming markets are small, while in the long run, the quantity of a product demanded and supplied may change significantly, since consumers and suppliers have sufficient time to adjust to price changes.

The results suggest that the price increases due to changes in costs are predicted to be small. The price increase associated with each product group increases by a much smaller proportion than the increase in the unit costs of production. The price change ranges between 0.17 and 0.31 of cost change from one copper forming product group to another.

In dollar terms, the regulation will cause price increases ranging from 0.4¢ per pound to 0.8¢ per pound. Based on an average price of $1.08 per pound for copper forming products the average percentage increase in price is less than 1 percent for the pollution control options. These empirical results are consistent with the market structure analysis in previous chapters (which indicate a competitive market for the copper forming products). In such

TABLE 7-1. DEMAND/SUPPLY ASSESSMENT OF EACH PRODUCT GROUP IN THE COPPER FORMING INDUSTRY

PRODUCT GROUPS	DEMAND OUTLOOK (Predicted Annual Growth Rate 1981-1990)	DEMAND ELASTICITY (Long-Run)	SUPPLY ELASTICITY (Long-Run)	PREDICTED RATIO OF PRICE INCREASE TO COST INCREASE
Sheet, Strip, and Plate (1)	3.3	-1.4	0.3	0.18
Rod, Bar, and Mechanical Wire (2)	2.6	-1.0	0.2	0.17
Commercial and Plumbing Tube and Pipe (3)	1.4	-0.9	0.4	0.31
Wire Mill Products (4)	4.0	-0.7	0.2	0.22

SOURCE: Compiled by JRB Associates from information provided in the demand/supply model.

TABLE 7-2. EXPECTED PRICE INCREASES BY COPPER FORMING PRODUCT GROUP (¢/lb)

POLLUTION CONTROL TREATMENT OPTIONS	PRODUCT GROUP			
	SHEET, STRIP, AND PLATE	ROD, BAR, AND MECHANICAL WIRE	TUBE AND PIPE	WIRE
Option 1	0.36	0.34	0.62	0.42
Option 2	0.47	0.44	0.81	0.57
Option 3	0.54	0.51	0.93	0.66

SOURCE: Compiled by JRB Associates.

markets, producers may be restricted by market forces from passing through all but a small portion of the cost increases to their customers by raising prices. A further observation is that a significant portion of the industry will not incur any compliance cost at all, because either they do not discharge wastewater or they are already in compliance. These firms will have no immediate need to raise prices and would gain market share if the other firms increase prices. For this reason, the above price increase estimates are overstated. Because of this factor, the profit impact and plant closure analysis described below uses the assumption of zero price increase.

The remainder of the economic impact analysis, therefore, focuses on the extent to which plants in the copper forming industry can remain financially viable and competitive domestically and abroad with added compliance costs imposed on them.

7.3 CAPITAL AVAILABILITY ANALYSIS

The capital availability analysis examines the ability of the copper forming plants to finance investments in new capacity and pollution control. As described in section 2.2.6, a discounted cash flow capital budgeting approach is used to determine whether a plant can afford to install the required pollution control equipment. For each plant, the analysis takes into account the cash returns expected over the life of the plant and equipment and the costs of capital. The plant will make the investment in pollution control, if the expected future revenues are greater than the future annual expenditures, plus the capital investment in pollution control.

The decision rule is if the NPV is positive the plant will invest; if the NPV is negative or zero the plant cannot afford to invest in pollution control. Furthermore, it can be assumed that if the firm can invest in pollution control and still remain profitable at a given cost of capital, then the financial markets would also be willing to finance the installation of the pollution control equipment.

The capital impact analysis uses the information provided by the copper forming industry 308 Economic Survey to calculate the expected cash flows for the individual plants. This analysis assumes that the expected cash flow of the plant will be the same as the average cash flow over the 1978 and 1979 period. Additionally, the analysis assumes that the expected cash flow will remain constant in real terms over the expected life of the plant (ten years). The cost of capital over this period is set at 13 percent.

The capital availability analysis examines a sample of plants in the copper forming industry to predict the number of plants that would be able to afford to install the proposed pollution control systems. The use of sample plants is necessary because adequate financial data (i.e., information on profits and depreciation) and compliance cost information are not available for all 82 plants that discharge wastewater. Of the 105 plants responding to the 308 Economic Survey, only 39 that provided adequate financial data for inclusion in this capital availability analysis are wastewater dischargers. Of these, 20 are indirect dischargers and 19 direct dischargers. Additionally, actual compliance cost estimates are not available for all 39 plants. In fact, actual compliance data are estimated for only 18 plants. For the remaining 21 plants, the analysis uses the highest compliance costs of the plants for which cost data are estimated. The results of the analysis indicate that all 39 of these sample plants would have positive net present values, indicating that all of the plants examined can afford any of the pollution control options. Extrapolating these results (based on the sample of copper forming plants examined) to all the copper formers leads to the conclusion that all firms would be able to afford the installation of the pollution control treatment systems needed to meet the effluent limitations.

Additionally, our previous analysis on the debt structure of corporations and reporting entities of the copper forming industry (see chapter 4) indicated that the copper formers were in a position to manage additional debt and they should be able to finance the required pollution control via outside sources, if necessary.

The analysis of capital availability for new sources is analagous to that of existing sources. An analysis of the costs for the pollution control equipment that new industrial dischargers are required to install to comply with the new source performance standards (NSPS and PSNS) indicates that the costs would not be different from those for existing direct and indirect dischargers. As a result, we do not expect any of the new sources' pollution control requirements to impose significant barriers to entry for new sources, regardless of whether these new sources are plants with major modifications or greenfield sites.

7.4 PLANT CLOSURE ANALYSIS

As described in section 2.2.7, a rational plant owner would keep the plant operating, if the before-and-after pollution control cash flows were greater than the salvage value of the plant. If the expected cash flows were less than the salvage value, the owner would be better off selling his plant. Since the plant will remain open for many years if the investment is made in pollution control, the analysis takes into account the cash flow expected over the life of the plant and equipment plus the salvage value at the end of the last period. The present value of future cash flows is calculated by discounting the expected income stream by the current cost of capital. The plant will remain open if the present value of the expected cash flows less the costs of investing in pollution control exceeds the expected salvage value. If the expected cash flows are less, the owner will sell the plant. Thus, the owner will close the plant if:

$$(7.5) \qquad S_o > \sum_{\eta=1}^{\eta} \frac{CASH_\eta}{(1+i)^\eta} - \sum_{\eta=1}^{\eta} \frac{C}{(1+i)^\eta} + \frac{S_\eta}{(1+i)^\eta} - I$$

where S is the salvage value of the plant and the other variables are the same as defined for equation 2.4 (see Chapter 2).

Plant-specific financial data (i.e., profits, depreciation, and salvage value) were provided by the copper forming industry 308 Economic Survey. The expected cash flow is the average cash flow over the 1978-1979 period, and it is predicted to remain constant in real terms (i.e., increase at the level of the inflation rate) over the life of the plant. The cost of capital is estimated at 13 percent. The investment and annual operating and maintenance costs for each of the pollution control options were determined in a separate study by EPA's Effluent Guidelines Division and are reported in Section VIII of the Development Document. The analysis examines the same sample of 39 plants discussed in section 7.3 to predict the number of plant closures that may result from the regulation.

The results of the plant closure analysis indicate that although the profitability of the plants will be reduced, none of the plants are likely to close if any of the pollution control options considered are imposed. Based on this plant closure analysis, we do not expect any of the plants in the copper forming industry to close as a result of the effluent guidelines.

An analysis using the 308 Economic Survey data was also conducted to determine baseline closures and our results indicated no closures. However, it should be noted that market conditions in a number of the product sectors since the survey was conducted (i.e., the 1981-1982 recession) was conducive to a number of baseline closures even in the absence of the regulation. Generally, the smaller, older, nonintegrated plants appear to be more vulnerable to a combination of increased competition from abroad and the economic recession here and abroad. Poor baseline performance is likely to be indicative of brass mills (especially tube and pipe plants) than the wire mills. Moreover, the long-term outlook for the industry is positive, indicating that most of the industry would experience increased revenues and profits during the 1980s. The results of the market analysis and the closure analysis indicate that, though neither brass nor wire mill closures are expected as a result of the regulation, wire mills are in a better financial and market position to afford the costs of pollution controls than brass mills.

7.5 OTHER IMPACTS

7.5.1 Employment and Community Impacts

The increase in costs resulting from compliance may cause employee layoffs if the added costs cause prices to increase, production to decrease, and plants to close. Our analysis, however, indicates that the compliance costs are not significant enough to cause the price of copper forming products to increase, production losses, or plant closures. For these reasons, this regulation would cause no employees to lose their jobs.

Community impacts generally stem from employment losses and plant closures. Since no plant closures or unemployment is expected to result from any of the pollution control options examined, the regulation will not create any community impacts.

7.5.2 Balance-of-Trade Impacts

The regulation would impact on the balance of trade depending on (1) the extent that copper forming product prices in the domestic market rise faster than prices in the rest-of-world market and (2) the extent to which the domestic production losses are replaced by imports from foreign countries. Since the regulation would have only negligible price or domestic output capacity effects, there would be no foreign trade impacts. Thus, domestic producers' competitive position vis-a-vis foreign producers will not change.

7.6 SMALL ENTITY ANALYSIS

Public Law 96-354, known as the Regulatory Flexibility Act, requires EPA to determine if a significant impact on a substantial number of small entities occurs as a result of the regulation. If there is a significant impact, the act requires that alternative regulatory approaches that mitigate or eliminate economic impacts on small businesses must be examined. This section addresses these objectives by identifying whether or not small entities of the copper forming industry are significantly impacted by the proposed regulation.

7.6.1 Defining Small Entities

The definition of small business is not precise or universal. The Small Business Administration (SBA) definition of "small business" generally means a specific number of employees for each manufacturing industry by Standard Industry Classification (SIC). For service, wholesale, retail, and other nonmanufacturing businesses, "small" is limited in SBA regulations by dollar amount of gross sales. In our analysis the number of employees is the primary variable used to distinguish size. Five employee size categories of copper forming plants are selected for examination and the production and financial characteristics of each were assessed. The five size categories are: 1-99, 100-299, 300-499, 500-999, and greater than 1,000 employees.

7.6.2 Baseline Conditions

Table 7-3 presents a disaggregation of the sample of 39 plants by employment size classification for key variables. It shows the discharge status (i.e., direct and indirect dischargers), value added, output, and the average profit margins of the copper forming plants in each employment category. The information on profit margins indicates that medium-sized plants with 300-499 employees are in the worst financial position. Consequently, they would be likely to be most affected by the regulation. It also indicates that the smallest plants (those with less than 100 employees) and the largest plants (those with more than 1,000 employees) are in the best financial position and are likely to be be least impacted by the regulation.

In addition, statistical tests were performed to determine whether the profitability of the plant differed by its size category. These tests revealed that there were no statistical differences in the performance of the copper forming plants that could be associated with their size.

TABLE 7-3. ANALYSIS OF COPPER FORMING SAMPLE PLANTS BY EMPLOYMENT CLASSIFICATION (in 1979)

EMPLOYEE CLASSIFICATION	DISCHARGE STATUS	# PLANTS RANKED BY EMPLOYEES	# EMPLOYEES	VALUE ADDED ($000)*	PRODUCTION (000/lbs)	AVERAGE PROFIT MARGIN (%)**
Total Employees	Total	39	42,186	1,563,596	3,610,177	19.22
	Indirect	20	28,835	882,393	2,300,160	19.4
	Direct	19	13,351	681,203	1,310,017	19.11
1 - 99 Employees	Total	5	286	23,539	34,241	20.0
	Indirect	3	103	4,862	7,745	20.0
	Direct	2	183	18,677	26,496	20.1
100 - 299 Employees	Total	11	1,978	272,663	472,885	19.5
	Indirect	4	696	57,800	106,152	15.8
	Direct	7	1,282	214,863	366,733	21.6
300 - 499 Employees	Total	5	1,780	67,944	137,653	10.5
	Indirect	1	385	19,999	52,050	3.0
	Direct	4	1,395	47,945	85,603	13.0
500 - 999 Employees	Total	10	6,579	346,603	1,776,359	22.6
	Indirect	7	4,405	255,512	1,486,202	25.6
	Direct	3	2,174	91,091	290,157	15.7
> 1,000 Employees	Total	8	31,563	852,847	1,189,039	17.3
	Indirect	5	23,246	544,220	648,011	5.0
	Direct	3	8,317	308,627	541,028	23.5

*1978 dollars.

**Profit margin is equal to the net profit divided by the value added of the plant.

SOURCE: Compiled by JRB Associates from the 308 Economic Survey.

7.6.3 Economic Impacts (Small Entities)

The discounted cash flow analyses presented in sections 7.3 and 7.4 are based on a sample of 39 plants that consist of 21 plants which have less than 500 employees. These analyses indicate that the plants examined can afford to install the pollution control equipment and would not close as a result of these added costs. Based on this analysis, the impact on small entities does not appear to be more significant or different than that of larger plants. Therefore, a formal regulatory flexibility analysis for the copper forming industry is not required.

8. LIMITATIONS OF THE ANALYSIS

This section discusses the major limitations of the economic impact analysis. It focuses on the limitation of the data, methodology, assumptions, and the implications for the results of this study. Methodology and limitations pertaining to the estimation of the plant-specific compliance cost estimates used in the analysis are outlined in the Development Document.[1]

The economic impacts analyzed are the result of the aforementioned effluent limitations and guidelines. The analysis assumes compliance with existing environmental regulations and excludes the economic impacts resulting from other new regulations such as air pollution control, OSHA requirements, and solid waste requirements.[2]

8.1 DATA LIMITATIONS

8.1.1 Economic Survey Data

The major assumptions and estimates that may have the greatest impact on the accuracy of the conclusions of this study relate to the data used in the plant-specific analysis. Even though the economic and financial data came directly from copper forming plants, conditions in the industry may have changed significantly enough that these data are no longer representative of the industry. The economic survey collected data for the 1976-1979 period. Since then the industry has experienced significant cutbacks in production and employment and losses in profits, as demand and prices for its products fell during the 1981-1982 recession. It is, therefore, possible that the financial performance of the firms in the latter part of the 1970s may not continue into the 1980s. However, the Agency has received no comments from industry on our estimates or provided additional data for analysis, since the formal proposal of this regulation in November 1982.

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[1] Development Document for Effluent Limitations Guidelines and Standards for the Copper Forming Point Source Category, EPA, July 1983.

[2] The impacts of the solid waste requirements caused by the technologies of this regulation are, of course, included in the analysis.

To evaluate whether the plant-specific information we currently have on the industry is still relevant, a separate study was carried out to determine the impacts of business cycles on the performance of the copper forming industry.[3] The information from this analysis was used to forecast the profitability of the industry during the 1984-1990 period. This analysis indicated that the industry's financial performance would improve to levels attained during the 1970s as the economy and the end-use markets for copper forming products expand. Based on this analysis, we believe that economic survey data are still appropriate for examining the impacts of this regulation.

8.1.2 Compliance Cost Data

This study uses "actual" plant-specific compliance cost estimates prepared for only 18 plants. However, compliance cost estimates are extrapolated to 21 other plants for which economic and financial data are available. The compliance costs for these plants are assumed to be equal to the highest costs of the 18 plants for which actual compliance cost data are available. It appears that these costs represent an upper bound estimate for the costs of the remaining plants. The analyses using these compliance costs show insignificant impacts.

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[3] Macroeconomic Conditions and Performance of Regulated Industries, JRB Associates, June 1983.

8.2 METHODOLOGY LIMITATIONS

8.2.1 Methodology

The methodology used to estimate the increase in prices due to the regulation is very sensitive to the estimates of the demand and supply elasticities. However, the price of copper is not determined by only the U.S. domestic industry, but by market factors in other countries. As a result, copper formers in the U.S. can not unilaterally increase the price of copper to cover the costs of this regulation without losing a significant market share and profits to foreigners. Therefore, the regulation would not cause the price of copper forming products to increase.

The criteria used in the plant closure and capital availability analysis are not all inclusive. They only examine the rational reasons for investing in pollution control equipment or for keeping a plant open. For example, they do not address behavior that may arise from personal reasons, or specific marketing strategy. Furthermore, the results of these analyses are limited by the assumptions used for calculating the key variables and parameters, especially the expected cash flow data and interest rates. Significant changes in these variables in the future could cause the results of the analysis to change.

8.2.2 Sensitivity Analysis on Key Assumptions

Sensitivity analyses were conducted to determine how the results of the study would change if the estimated cost of capital and cash flows changed. The interest rate used in the discounted cash flow analyses was increased from 13 percent to 18 percent. The results of this analysis suggest that none of the plants would close from the promulgation of this regulation. It is extremely difficult to predict economic conditions that may affect the financial performance of plants in the future. However, based on our analysis of the performance of the industry during the 1984-1990 period, we believe the cash flow position of the plants would be similar to what they experienced during the 1970s.[4] We carried out separate sensitivity analyses using the 1978 and 1979 cash flows as estimates of the expected cash flow of the plants, and the results were similar to the final results of the study.

8.3 MONITORING COST SENSITIVITY ANALYSIS

EPA estimates that facilities covered under this regulation will monitor their effluent for toxic organics. Large plants with large effluent flow rates are expected to monitor their waste streams more frequently than small plants. Our analysis reflects EPA's Effluent Guidelines Division estimates of monitoring requirements. These estimates assume large plants would monitor their wastewaters three times a week at a cost of $120 for each sample and small plants would monitor their waste streams only once a month. The annual monitoring costs are estimated to be $18,000 for large plants and $1,440 for small plants.

Local authorities and permit writers have discretion in specifying monitoring frequencies. It is possible that the small plants would be required to monitor their effluent more often, thus incurring higher costs than were estimated in the study. A sensitivity analysis was conducted to determine the impacts of higher monitoring costs on small plants. This analysis assumed that the small plants would have to monitor their waste streams at least ten times a month. This level of monitoring frequency would add $0.8 million, increasing industry's total annual cost for BAT and PSES from $14.0 million to $14.8 million. The results of our analysis of these higher monitoring costs indicate that the higher monitoring costs would not cause any of the small plants to close at the selected option (Option 2). However, one of the small plants would close if the regulation were to be promulgated at the Option 3 level. Since Option 3 is not the selected option, these findings do not alter the results of the study. Even with increased monitoring frequency requirements, this regulation is economically achievable.

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[4] Ibid.